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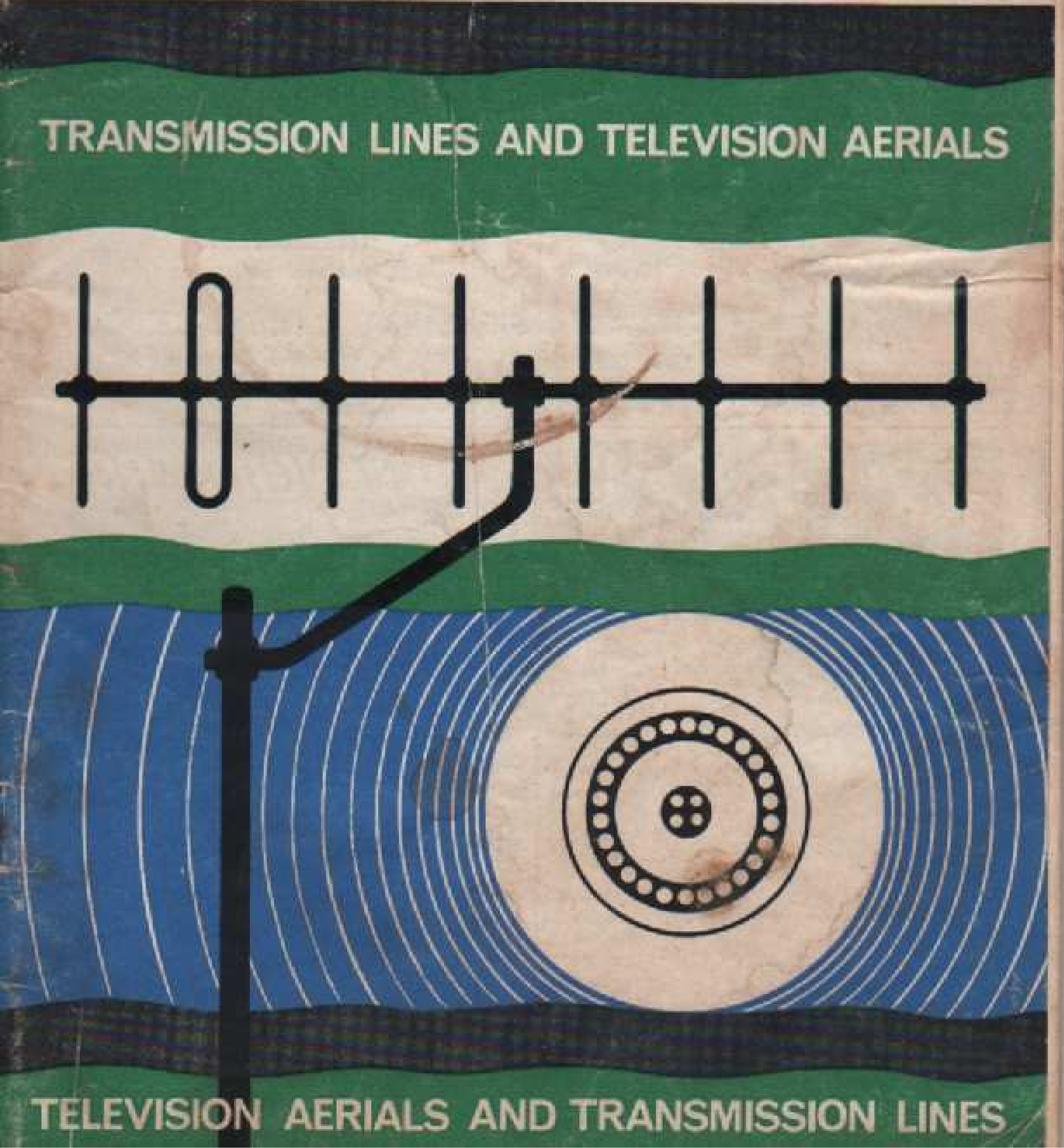

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1S5	[illegible]	10F18	[illegible]	DF91	[illegible]	EF41	[illegible]	PCF86	[illegible]	[illegible]	[illegible]
1T4	[illegible]	12AT7	[illegible]	DF96	[illegible]	EF80	[illegible]	PCF800	[illegible]	[illegible]	[illegible]
3A5	[illegible]	12AU6	[illegible]	DH77	[illegible]	EF85	[illegible]	PCF801	[illegible]	[illegible]	[illegible]
3Q4	[illegible]	12AU7	[illegible]	DK32	[illegible]	EF86	[illegible]	PCF802	[illegible]	[illegible]	[illegible]
3S4	[illegible]	12AX7	[illegible]	DK91	[illegible]	EF89	[illegible]	PCF805	[illegible]	U301	[illegible]
3V4	[illegible]	12K8GT	[illegible]	DK92	[illegible]	EF91	[illegible]	PCF806	[illegible]	U801	[illegible]
5U4G	[illegible]	20F2	[illegible]	DK96	[illegible]	EF92	[illegible]	PCL82	[illegible]	UABC80	[illegible]
5V4G	[illegible]	20L1	[illegible]	DL33	[illegible]	EF97	[illegible]	PCL83	[illegible]	UAF42	[illegible]
5Y3GT	[illegible]	20P1	[illegible]	DL35	[illegible]	EF183	[illegible]	PCL84	[illegible]	UBC41	[illegible]
5Z4G	[illegible]	20P3	[illegible]	DL92	[illegible]	EF184	[illegible]	PCL85	[illegible]	UBF80	[illegible]
6/30L2	[illegible]	20P4	[illegible]	DL94	[illegible]	EL33	[illegible]	PCL86	[illegible]	UBF89	[illegible]
6AL5	[illegible]	25U4GT	[illegible]	DL96	[illegible]	EL41	[illegible]	PEN/A4	[illegible]	UBL21	[illegible]
6AM6	[illegible]	30C15	[illegible]	DY86	[illegible]	EL42	[illegible]	PEN36C	[illegible]	UC92	[illegible]
6AQ5	[illegible]	30C17	[illegible]	DY87	[illegible]	EL84	[illegible]	PEN383	[illegible]	UCC84	[illegible]
6AT6	[illegible]	30C18	[illegible]	EABC80	[illegible]	EL95	[illegible]	PFL200	[illegible]	UCC85	[illegible]
6BA6	[illegible]	30F5	[illegible]	EAF42	[illegible]	EM80	[illegible]	PL36	[illegible]	UCF80	[illegible]
6BE6	[illegible]	30FL1	[illegible]	EB41	[illegible]	EM81	[illegible]	PL81	[illegible]	UCH42	[illegible]
6BJ6	[illegible]	30L15	[illegible]	EB91	[illegible]	EM84	[illegible]	PL82	[illegible]	UCH81	[illegible]
6BW6	[illegible]	30L17	[illegible]	EBC33	[illegible]	EM87	[illegible]	PL83	[illegible]	UCL82	[illegible]
6F1	[illegible]	30P4	[illegible]	EBC41	[illegible]	EY51	[illegible]	PL84	[illegible]	UCL83	[illegible]
6F13	[illegible]	30P12	[illegible]	EBF80	[illegible]	EY86	[illegible]	PL500	[illegible]	UF41	[illegible]
6F14	[illegible]	30P19	[illegible]	EBF89	[illegible]	EZ40	[illegible]	PL801	[illegible]	UF89	[illegible]
6F23	[illegible]	30PL1	[illegible]	ECC81	[illegible]	EZ41	[illegible]	PL802	[illegible]	UF80	[illegible]
6K7G	[illegible]	30PL13	[illegible]	ECC82	[illegible]	EZ80	[illegible]	PX25	[illegible]	[illegible]	[illegible]
6K8G	[illegible]	30PL14	[illegible]	ECC83	[illegible]	EZ81	[illegible]	PY33	[illegible]	UL41	[illegible]
6K8GT	[illegible]	35L6GT	[illegible]	ECC84	[illegible]	GZ32	[illegible]	PY81	[illegible]	UL84	[illegible]
6L18	[illegible]	35W4	[illegible]	ECC85	[illegible]	KT61	[illegible]	PY82	[illegible]	UY41	[illegible]
6V6G	[illegible]	35Z4GT	[illegible]	ECF80	[illegible]	N78	[illegible]	PY83	[illegible]	UY85	[illegible]
6V6GT	[illegible]	85A2	[illegible]	ECF86	[illegible]	N18	[illegible]	PY88	[illegible]	U4020	[illegible]
6X4	[illegible]	185BT	[illegible]	ECH35	[illegible]	PC86	[illegible]	PY800	[illegible]	VP4B	[illegible]
6X5GT	[illegible]	6063	[illegible]	ECH42	[illegible]	PC88	[illegible]	PY801	[illegible]	VP1321	[illegible]
7B6	[illegible]	AZ31	[illegible]	ECH81	[illegible]	PC97	[illegible]	[illegible]	[illegible]	W77	[illegible]
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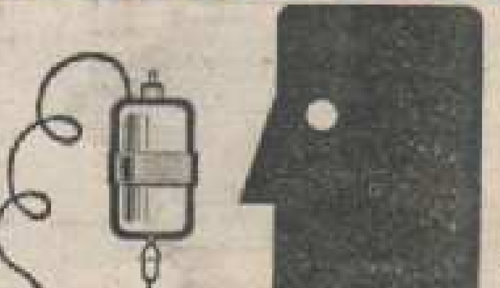

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Practical Television

MAY 1967
VOL. 17 No. 8
Issue 200

BLACK YEAR

It is ironic that in the year Colour comes to TV the clouds over the heads of the TV trade should be so black! Gloom and despondency greets the provisions of the Wireless Telegraphy Bill which concern TV licences. For although everyone agreed that something had to be done to plug the hole through which £10M pours each year, we are now beset with bellyaching about "snoopers" and "moral codes".

No one has yet accused local Post Office managers of snooping on the honest viewers who have obtained TV licences. And we wonder if a dealer caught somebody breaking into his shop whether he would demonstrate his moral principles and let him go or become a snooper and tell the police?

In any case, opportunities for "snooping" are getting scarcer. From the lofty altitudes of the 1959 peak of 2·75 million sets, sales have slithered down to 1·9M in 1964, 1·68M in 1965 and only 1·29M in 1966. The drop in 1966 over the previous year was 390,000 sets, or 23%. Indecisions about colour and broadcasting standards may have tempted viewers to hang on to their old sets longer and the present Government's economic measures have undoubtedly had some effect. But these factors are not the root cause of the continual slide.

Potential stimulants like the introduction of BBC-2 have failed to have any significant impact. The mass audience just does not want true alternative programmes—they want only a multiplicity of the same sort of programmes, as ratings for top shows confirm.

During the period from peak 1959 to slump 1966 the sales of TV sets have dropped by over 50%. We think the downward trend will probably continue, for the TV industry must resign itself to a replacement-only market. As coverage by BBC and ITA has spread, the potential sale for new sets has declined, as it has, ironically, with more reliable sets.

It would be nice to think that colour will be a shot in the arm; nice, but unrealistic. Until production can be built up and retail prices reduced, sales are not likely to be phenomenal. Colour *will* be successful, but it will be a long slow haul.

More is the pity, then, that instead of grasping the golden opportunity in this Colour Year of splashing colour with fanfares and, even, ballyhoo, to arouse interest and enthusiasm in viewers no public radio and TV show has been organised for the autumn—only a scattered series of trade-only exhibitions. Sometimes we despair of this crazy industry!

W. N. STEVENS—*Editor*.

THIS MONTH

OUR NEXT ISSUE DATED JUNE WILL BE PUBLISHED ON MAY 19

TELETOPICS

New bill hits at licence dodgers

THE problem of television licence evasion is tackled in the Wireless Telegraphy Bill. The Bill is designed to provide the Post Office with information not only about the purchase and hire of new television sets, but also about sets already held on rental or hire purchase agreements when it becomes law.

The Post Office estimates that there are two million households with unlicensed television sets, and £10M in revenue is lost each year. Measures against evasion depend upon a comparison of lists of households with television, and of those with licences. To make the first of these lists complete television dealers will have to provide the Post Office with the names and addresses of everyone who buys or hires a set. All dealers will therefore have to register with the Post Office.

Maximum penalties to which evaders are liable on conviction under the Wireless Telegraphy Act, 1949, would be increased, under the new Bill, from the present £10 for a first offence to £50; and from £50 for a subsequent offence to £100.

Educational TV service for London schools and colleges

THE first studio equipment for an Educational Television Service, covering 1,300 schools and colleges in Inner London, is currently being supplied by the Marconi Company. A Television Centre, initially with two studios, is being established at Laycock School in Islington by the Inner London Education Authority, the start of a scheme which will be the largest closed circuit system in the British Isles and one of the most advanced and ambitious in the world.

The photograph shows installation work in progress on the main studio and control room.

TV in the Mersey Tunnel

THE Mersey Tunnel largest closed circuit television system for traffic control, became fully operational recently after an inspection by the Joint Mersey Tunnel Committee, headed by the Chairman, Alderman W. H. Sefton.

Supplied and installed by EMI Electronics, the TV system enables the trained observers of the Mersey Tunnel Police to keep a minute-by-minute watch on the flow of traffic through the Tunnel and into each of its four entrances.

Over the last ten years, the volume of traffic using the Tunnel has increased by an average 800,000 vehicles each year and last year a total of 17,742,857 vehicles was recorded. During the morning and evening peak periods, a tidal flow system is operated opening three of the Tunnel's four lanes in the direction of maximum flow.

With traffic in such volume, any interruption of the flow through the Tunnel results in serious disruption of the metropolitan traffic of Liverpool and Birkenhead, particularly scheduled bus services. A breakdown at peak time, when lanes may be carrying up to 2,000 vehicles an hour, can result in queues of vehicles over half a mile long at the entrances.

Technical writing course

INTERNATIONAL Correspondence Schools now have a home-study course on technical writing which covers the syllabus of the City and Guilds of London Institute certificate examination (329). This course is geared to the special needs of technicians, technologists, engineers, scientists, technical journalists and others. It is designed to give practice in obtaining, sorting and using the information required for technical articles and report writing and as a part of the syllabus, the student is asked to complete five selected technical writing assignments.

Full details of the course are available from the Principal, ICS Ltd., Intertext House, Parkgate Road, London, S.W.11.

BROMSGROVE BBC-2 RELAY STATION

THE first of the BBC-2 relay stations for the Midlands was brought into service at Bromsgrove on Monday, March 13th. It transmits BBC-2 on Channel 27 with vertical polarisation.

For satisfactory reception of BBC-2 on u.h.f. it is very important that the correct type of aerial is used and that it is carefully positioned. For Bromsgrove the aerial must have vertical rods; it must be suitable for Channel 27 and for the other three channels, 21, 24 and 31 which have been assigned to this station for future u.h.f. services. The same aerial will also be suitable for the colour programmes when these are introduced into BBC-2 towards the end of this year.

The Bromsgrove station will serve some 75,000 people in Bromsgrove, most of Droitwich and their environs, including the villages of Chaddesley Corbett, Tibberton, Bentley and Bell Heath.

Closed Circuit Television Boosts Q and R year at Mullard's

AT the Simonstone television picture tube production factory of Mullard Ltd., closed circuit television is being used to acquaint workers with the aims and objects of Quality and Reliability Year (October 1966—October 1967).

Programmes on various aspects of Quality and Reliability are being broadcast regularly over eight television sets placed in the factory's three canteens. Programme content ranges from the presentation of cash prizes to the winners of competitions designed to boost Q and R, to showing films such as "Right First Time" and "According to Specification" distributed by the British Productivity Council.

The system comprises a Peto Scott 625-line Vidicon camera which gives an output in Band 1. Sound is distributed through a 20W amplifier and fed to the speakers of the standard 23in. 405/625 line receivers—all of which are fitted with picture tubes made at Simonstone. Films can be shown with the aid of a film scanner designed by the plant's Technological Dept.

FIRST COLOUR TV RENTED

MR. Henry Jackson, a Director of the British Printing Corporation, ordered the first colour TV set from Radio Rentals at the Ideal Home Exhibition. He intends installing his Regency-style set next to his bar in his home at Sevenoaks, Kent.

£230,000 colour TV orders

BUSH Murphy division of The Rank Organisation have received further orders for colour television studio equipment worth a total of £230,000.

These orders, placed by the BBC, ATV Network and ABC Television, are for Rank Cintel Flying Spot Telecines, Slide and Opacity Scanners and associated equipment.

The BBC's order covers the supply of 16mm. Colour Telecines, Broadcast Slide Scanners and an Opacity Scanner, for conversion to colour of their studio complex at the TV Centre and other premises.

Both of the Independent Television companies, ATV and ABC Television have ordered a number of Colour Telecine equipments. This is a significant contribution to the build-up of capital equipment by the independent television companies in preparation for commercial colour television.

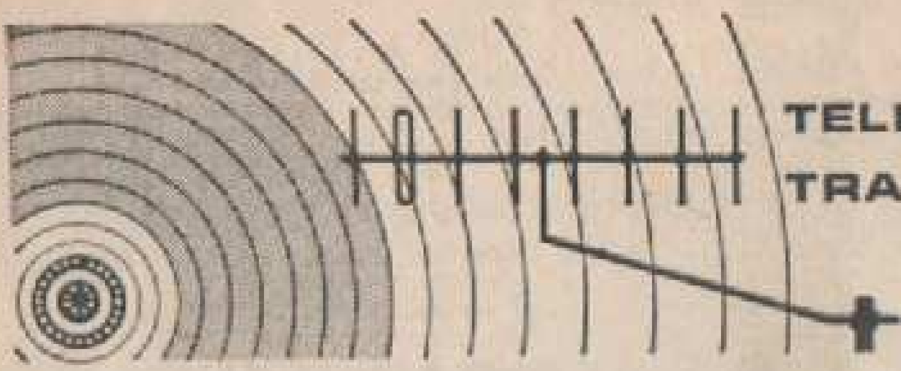
TV FOR MEDICAL DIAGNOSIS

MEDICAL and surgical use of television and film techniques for diagnosis, research and education will highlight the medical sessions at the forthcoming Technical Conference of the Society of Motion Picture and Television Engineers (SMPTE) in New York.

The Conference is set for April 16—21 at the New York Hilton Hotel.

There will be a closed circuit demonstration of infra-red techniques to localise cancer and vascular diseases, and from the cardio-vascular operating rooms of St. Barnabas Hospital, the technique of using television will be demonstrated.

Smith, Kline and French Laboratories, Philadelphia, will provide the colour camera pick-up, and one of the networks will record and edit the tape, and provide the television studio during the Conference.



TELEVISION AERIALS & TRANSMISSION LINES

by Keith Chaplin

ALTHOUGH today's television aerial designers know a good deal more about transmission lines and aerials than their predecessors, most of them finalise their design models by the trial and error method. Then polar diagrams of the radiating field (explained later) are produced before final adjustments are made to obtain the wanted characteristics.

It is not, however, the author's intention to go into the methods used by the professionals to make specialist aerials, but to give the reader an insight into methods employed in transmitting and receiving television signals.

Before going into detail, one should realise what an aerial is. Basically, it is a tuned conductor which has to change electrical signals into electromagnetic waves (when used for transmitting) or more commonly to convert electromagnetic waves into electrical signals. The actual characteristics of transmitting and receiving aerials are similar, but basically differ inasmuch as one has to handle large amounts of power while the other has to be able to convert electromagnetic waves into electrical signals that can be amplified and used in the television receiver. Also one should understand the basic principles before delving into other problems such as bandwidth, noise factors, directivity, etc.

Principles of Radiation

Radiation principles are based upon the fact that a moving electric field creates a magnetic field, and vice versa. In fact, any radio frequency current in a wire of finite length will produce electromagnetic fields which can be set free. The waves radiated from a simple conductor leave in all directions; rather like the ripples generated on the surface of a still pond after throwing a stone into its centre.

Another proven scientific fact is that radio waves, whatever the frequency, travel at approximately the speed of light (about 186,000 miles per second or expressing it another way, 300,000,000 metres per second). Thus, since velocity of a radio wave is constant, one can determine its wavelength (the distance travelled by the radio wave in the time required to complete one cycle) by dividing the velocity by the frequency of the wave.

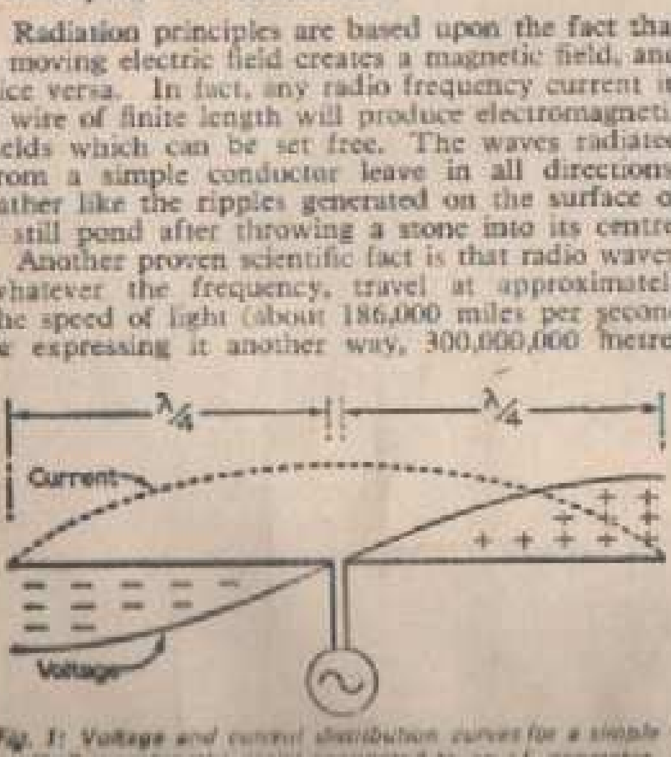


Fig. 1: Voltage and current distribution curves for a simple ½λ (half wavelength) aerial connected to an r.f. generator

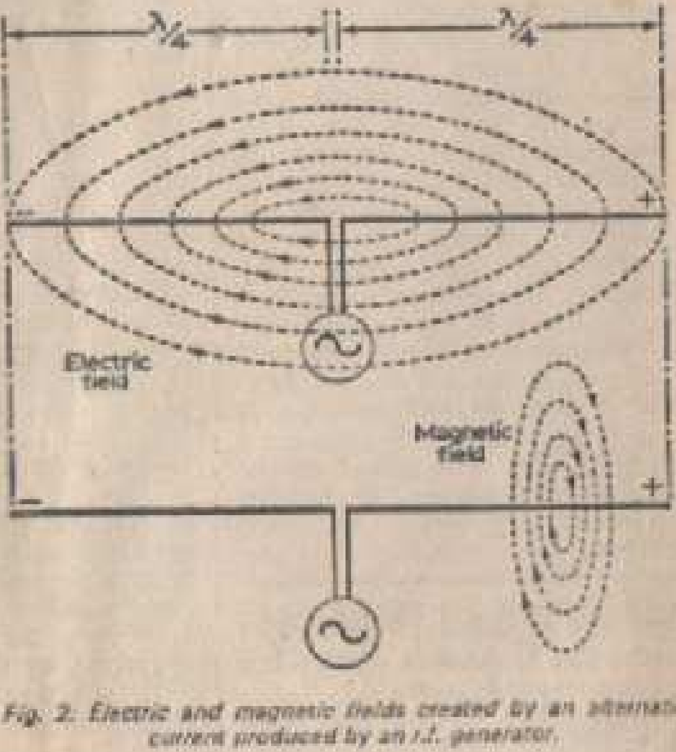


Fig. 2: Electric and magnetic fields created by an alternating current produced by an r.f. generator.

Hence, $\lambda = \dfrac{300,000,000}{f}$

where λ is wavelength in metres and f is frequency in cycles per second.

Half-wave Dipole

The simplest form of television aerial is the dipole. Although the two elements that form the conventional centre-fed dipole may be of any length up to a full wavelength, an overall length of just under half a wavelength is generally chosen by the aerial designer. The reason for this will become evident later.

Figure 1 shows the voltage and current distribution for a half waveleigth dipole. As it can be seen the voltage is at maximum and the current at zero at the ends while the current is at maximum and voltage at minimum at the centre tap. During the duty cycle of the generator attached to the aerial, the polarity at the ends of the dipole change with the generator. With a voltmeter connected to the ends of the dipole and an ammeter to the centre, you will find that the centre voltage and current readings are in phase while the voltage readings are out of phase with the generator. Thus, it can be concluded that a dipole has both distributed inductance and capacitance, and is a resonant circuit.

With an alternating current flowing in an aerial, an alternating current is set up round it, see Fig. 2. This, of course, changes polarity in sympathy with the r.f. generator. This electric field also produces a magnetic field (as mentioned earlier) and combines with the magnetic field set up around the dipole. The resulting electromagnetic field can travel great distances, but like light waves, its intensity is inversely proportional to distance.

Principles of Reception

When a radiated electromagnetic field hits a conductor, some of the energy is absorbed by the conductor. This energy causes a few of the electrons in the conductor to move and, thus, produces an alternating current. The amplitude of this current is determined by the input impedance of the aerial and the r.f. voltage at that point.

Ohm's law for alternating current may be used to find the input impedance: $Z = \frac{E}{I}$

where Z is the aerial impedance, E the r.f. voltage and I the current.

The impedance of a centre-fed (current feed) half-wave dipole is about 75Ω; end fed (voltage feed) aerials have a much higher impedance at half wavelength and is often in thousands of ohms. Thus, the length of the two elements forming the simple dipole is important in determining the correct impedance to obtain the best voltage and current transfer characteristics. It is not, however, the only factor, since the diameter of the conductors affects the capacitive inductance and, thus, the impedance and the bandwidth of the aerial.

Electrical Length

Another important factor to remember is that the electrical length of the conductors is only the same as the physical length in free space. Since an aerial has to be supported by insulators whose dielectric constant is greater than unity the velocity of a wave along a conductor is slightly less than in free space. Thus, to achieve the best possible results, this factor has to be taken into consideration when calculating element lengths. Generally designers cut the conductors so that their physical length is 5 per cent shorter than the calculated electrical length.

Calculating the Dipole Length

Summarising, the overall length of the half-wave dipole can be calculated from the following formula:

$$L = \frac{300{,}000{,}000 \times 0{\cdot}95}{2f}$$

where L is the overall length and f is the wanted frequency. The space between the two elements (for the centre connection) should be about half an inch.

As an example, the dimensions for a half-wave dipole cut for the BBC-1 London transmitter can be found as follows:

First find the centre frequency the aerial has to operate at: the vision frequency is 45Mc/s and the sound is 41·5Mc/s, thus the centre frequency

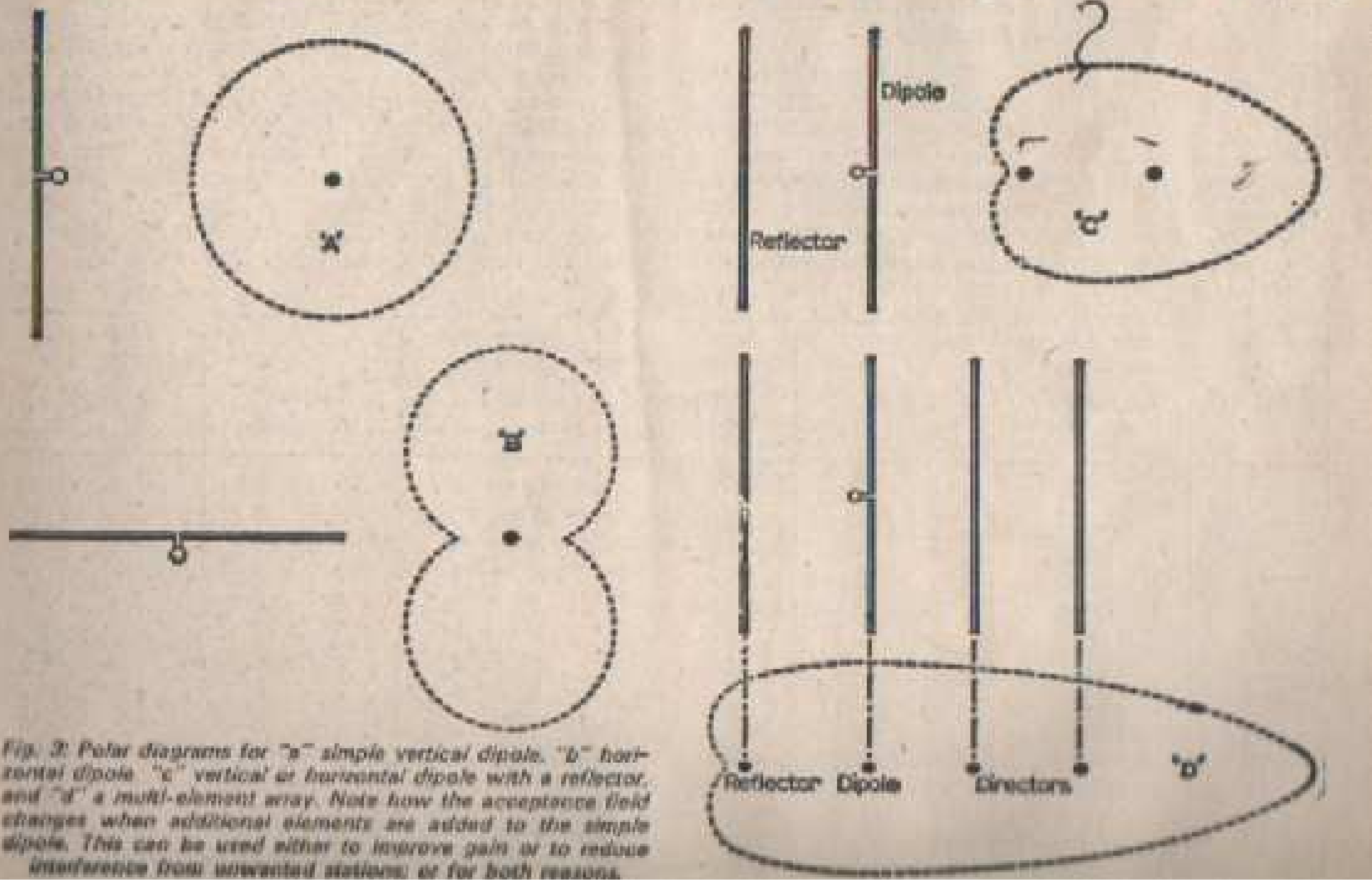


Fig. 3: Polar diagrams for "a" simple vertical dipole, "b" horizontal dipole, "c" vertical or horizontal dipole with a reflector, and "d" a multi-element array. Note how the acceptance field changes when additional elements are added to the simple dipole. This can be used either to improve gain or to reduce interference from unwanted stations; or for both reasons.

is 43·25Mc/s.

$$L = \frac{300,000,000 \times 0{\cdot}95}{2 \times 43,250,000}$$

$$L = \frac{14,250}{4,325}$$

$$L = 3{\cdot}295 \text{ metres.}$$

To convert metres into feet multiply by 3·26.
3·295 x 3·26 = 10·74 feet.

Noise and Interference

Modern television receivers are extremely sensitive and do not require a very large signal to operate satisfactorily. However, the signal has to be fairly strong to overcome noise picked up on the aerial and noise generated in the receiver itself. Also, the aerial should be selective in frequency to minimise r.f. interference and in direction to minimise interference from reflected "wanted" signals and other signals on near or identical frequencies.

One of the simplest ways of doing this is to add a reflector to the half-wave dipole. The next step is to add directors, but one cannot do either without making allowances in the original design to maintain the original impedance characteristics.

Fig. 4: When cutting a dipole measurements should be made as shown in the illustration.

Adding to the Basic Dipole

Figure 3 contains polar diagrams for the basic half-wave dipole, a dipole plus reflector and a multi-element array containing a dipole reflector and a number of directors. If one was to simply add a reflector and half a dozen directors to a half-wave dipole the input impedance of approximately 75Ω would fall to about 10Ω. This would make the aerial useless due to the losses encountered in mismatch in the feeder cable and the front-end of the receiver. A reflector element does not have so much effect on the aerial input impedance as does a director. In fact, it can be used (by changing the spacing of it in relation to the dipole) to improve the matching with the feeder and the receiver.

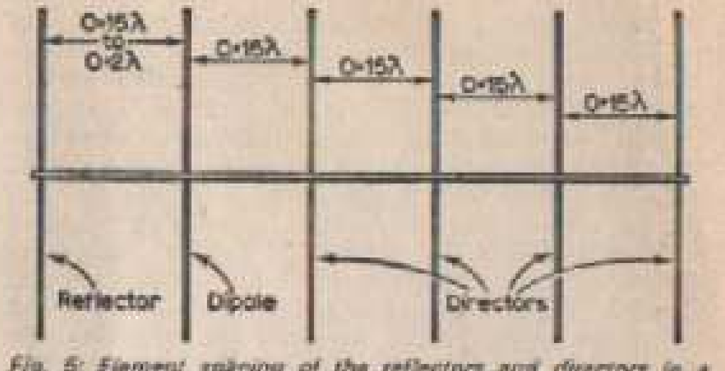


Fig. 5: Element spacing of the reflectors and directors in a multi-element array. The actual spacing of the reflector can be adjusted within the defined limits to obtain correct impedance matching.

The reflector can be made from the same type of rod as the dipole itself. As to length, it should be about 5 per cent longer than the dipole and does not need to be broken in the centre since it is a parasitic element, that is to say it absorbs some of the incoming signal and re-radiates it to add to the field surrounding the dipole. Spacing from the dipole is, of course, important. Generally it is somewhere between 0·15 and 0·22 of a wavelength. This, however, reduces the input impedance to around 20Ω, but cuts out all signals coming from the rear and improves the forward and side gain.

To maintain a reasonable input impedance in multi-element arrays, designers often fold the dipole (see Fig. 4). This increases the impedance by a factor of approximately four. When calculating the physical and electrical lengths of a folded dipole, one should take the overall length to be from the two end corners (see Fig. 4).

TABLE 1

Channel	*Centre Frequency (Mc/s)*	*Dipole*		*Reflector*		*Reflector to Dipole spacing*		*Director*		*Director to Dipole spacing*	
		ft.	*in.*	*ft.*	*in.*	*ft.*	*in.*	*ft.*	*in.*	*ft.*	*in.*
1	43·5	10	7	11	1	5	7	10	0	3	4
2	50·0	9	3	9	9	4	10	8	8	2	11
3	55·0	8	5	8	11	4	5	7	11	2	8
4	60·0	7	8	8	1	4	1	7	3	2	5
5	65·0	7	1	7	6	3	9	6	8	2	3
6	178·0	2	7½	2	9	1	4¾	2	6	–	9¾
7	183·0	2	6½	2	8	1	4½	2	5	–	9½
8	188·0	2	5½	2	7	1	4	2	4	–	9¼
9	193·0	2	4½	2	6	1	3½	2	3	–	9⅛
10	198·0	2	3½	2	5	1	3¼	2	2½	–	9
11	203·0	2	3	2	4½	1	2¾	2	2	–	8¾
12	208·0	2	2½	2	4	1	2¾	2	1½	–	8½
13	213·0	2	2	2	3	1	2¼	2	1	–	8¼

TABLE 2
UK TELEVISION CARRIER FREQUENCIES IN Mc/s

Channel	*Sound*	*Vision*	*Centre Frequency*
1	41·5	45·0	43·25
2	48·25	51·75	50·00
3	53·25	56·75	55·00
4	58·25	61·75	60·00
5	63·25	66·75	65·00
6	176·25	179·75	178·00
7	181·25	184·75	183·00
8	186·25	189·75	188·00
9	191·25	194·75	193·00
10	196·25	199·75	198·00
11	201·25	204·75	203·00
12	206·25	209·75	208·00
13	211·25	214·75	213·00
14	216·25	219·75	218·00
15 to 20 inclusive not used			
21	477·25	471·25	474·25
22	485·25	479·25	482·25
23	493·25	487·25	490·25
24	501·25	495·25	498·25
25	509·25	503·25	506·25
26	517·25	511·25	514·25
27	525·25	519·25	522·25
28	533·25	527·25	530·25
29	541·25	535·25	538·25
30	549·25	543·25	546·25
31	557·25	551·25	554·25
32	565·25	559·25	562·25
33	573·25	567·25	570·25
34	581·25	575·25	578·25
35 to 38 inclusive not used			
39	621·25	615·25	618·25
40	629·25	623·25	626·25
41	637·25	631·25	634·25
42	645·25	639·25	642·25
43	653·25	647·25	650·25
44	661·25	655·25	658·25
45	669·25	663·25	666·25
46	677·25	671·25	674·25
47	685·25	679·25	682·25
48	693·25	687·25	690·25
49	701·25	695·25	698·25
50	709·25	703·25	706·25
51	717·25	711·25	714·25
52	725·25	719·25	722·25
53	733·25	727·25	730·25
54	741·25	735·25	738·25
55	749·25	743·25	746·25
56	757·25	751·25	754·25
57	765·25	759·25	762·25
58	773·25	767·25	770·25
59	781·25	775·25	778·25
60	789·25	783·25	786·25
61	797·25	791·25	794·25
62	805·25	799·25	802·25
63	813·25	807·25	810·25
64	821·25	815·25	818·25
65	829·25	823·25	826·25
66	837·25	831·25	834·25
67	845·25	839·25	842·25
68	853·25	847·25	850·25

Directors

Directors are also parasitic elements and must be cut to specific lengths and correctly positioned to obtain maximum gain without affecting the input impedance to any extent. The spacing between the dipole and the first director should be 0·1 of a wavelength for maximum gain, but as a compromise (gain to impedance) most designers space the first director 0·15 of a wavelength away from the dipole. Spacing between subsequent directors should be same as that between the first director and the dipole.

Overall length of the first director should be 5 per cent less than the dipole and the following directors should be reduced in length by the same amount.

Actual Dimensions

The actual dimensions of the elements needed for aerials to cover BBC-1 and ITA television channels are given in Table 1. Dimensions for BBC-2 aerials have not been included, since it is planned to allocate each area with four channels at a later date so that one wideband aerial can cover all the television programmes when the conversion from 405 to 625 lines has been completed. However, for those wanting to build an aerial for the present single channel (for BBC-2), a table has been included giving vision and sound frequencies for all the channels in the u.h.f. band. As a point of interest, the author has found that aerials cut to the vision frequency work better than those cut between the vision and sound frequencies.

The formula given earlier for determining element lengths is perfectly suitable, and it is suggested that constructors should use 3/16in. tubing to obtain the necessary bandwith at u.h.f. On Band I, ½in. tubing is recommended, while ¼in. is for Band III aerials. Fig. 5 shows spacing details.

Aerial Feeders

Little need be said about television downleads other than to say that generally you get what you pay for. Low loss cable is expensive and often is needed where there is a long run or u.h.f. signals have to be carried. The losses over thirty to forty feet should not cause any problems and in installations having feeders of greater length, an amplifier of some sort should be used. Several of these have been described in PRACTICAL TELEVISION over the years. ■

EXTRA HIGH TENSION METER

by Martin L. Michaelis, M.A.

SECOND AND FINAL PART

D.C. MEASUREMENTS

The meter is intended for d.c. voltage measurements only, and normally with reference to chassis. In other words, Sk2 should normally be connected to chassis of the equipment under test. All ranges may be switched to read positive or negative with respect to chassis. This is effected with S1 which simply reverses the direction in which the probe current flows through the meter input chain R7, VR1, VR2, VR3, so that R7 is always at the positive end as required by the amplifier and meter circuit. Negative e.h.t voltages with respect to chassis are frequently encountered in oscilloscopes, so the polarity selector S1 is essential.

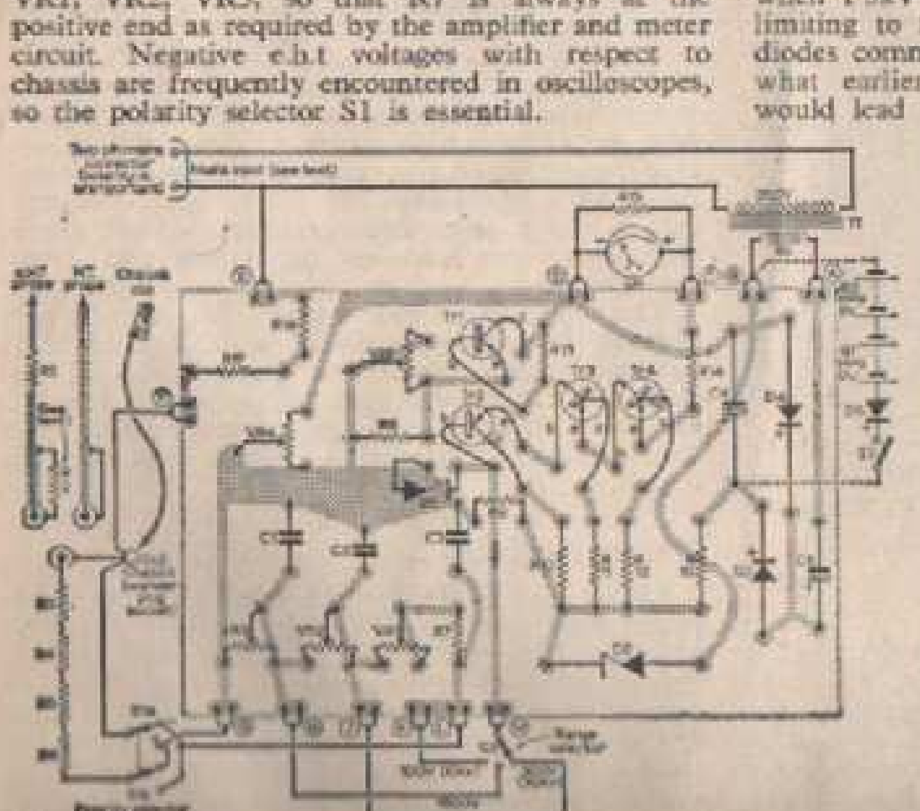


Fig. 2: Printed circuit board, showing component positions

OVERLOAD PROTECTION

It is impossible to damage the meter on any range, even if the polarity selector is set incorrectly, for any actual input voltage within the ratings of the repective probes (1·5kV for the h.t. probe, 30kV for the e.h.t. probe). The zener diode D1 limits correct polarity meter current to roughly double full scale deflection, so that the pointer moves sharply but safely to the right-hand stop even when 1·5kV is applied on the 100V range. Closer limiting to full scale is inadvisable because zener diodes commence to conduct logarithmically somewhat earlier than at their zener voltage which would lead to non-linearity of the meter scale. If the input voltage is of incorrect polarity with respect to S1 setting, D1 will conduct at a voltage level equal to only a small fraction of the full scale deflection value, so that the meter pointer will move gently to the left-hand stop, indicating the incorrect polarity.

BATTERY OPERATION

As soon as the mains plug is withdrawn from Sk3, the circuit will float at a high e.h.t. potential in spite of R17 and R18 if the e.h.t. probe is touched onto a final anode and the chassis connection omitted. But this stress is not impressed across the mains transformer or any other individual component, so no damage is likely. Resistors R17 and R18 still provide a leak between the mains transformer windings, so that there is no possible danger to this component. This is the state of affairs if S3, D5 and the batteries are fitted, S3 is

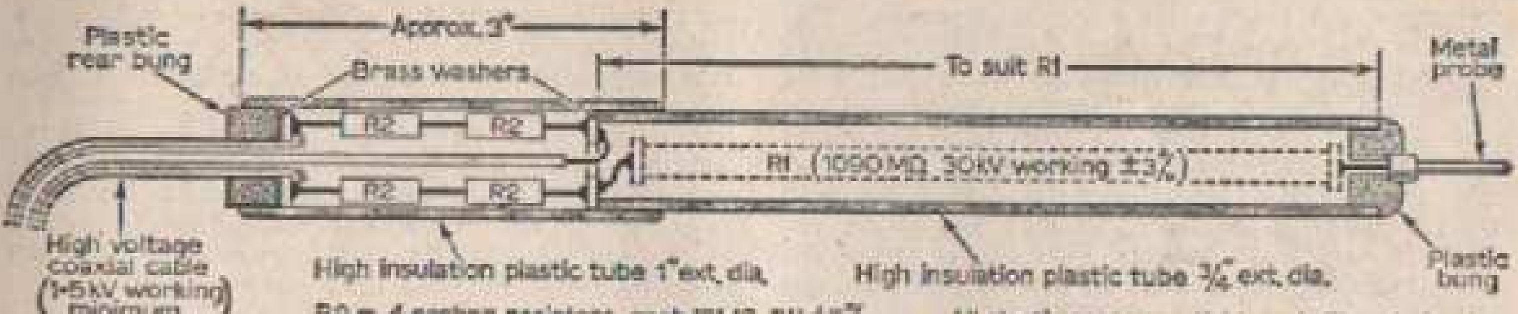
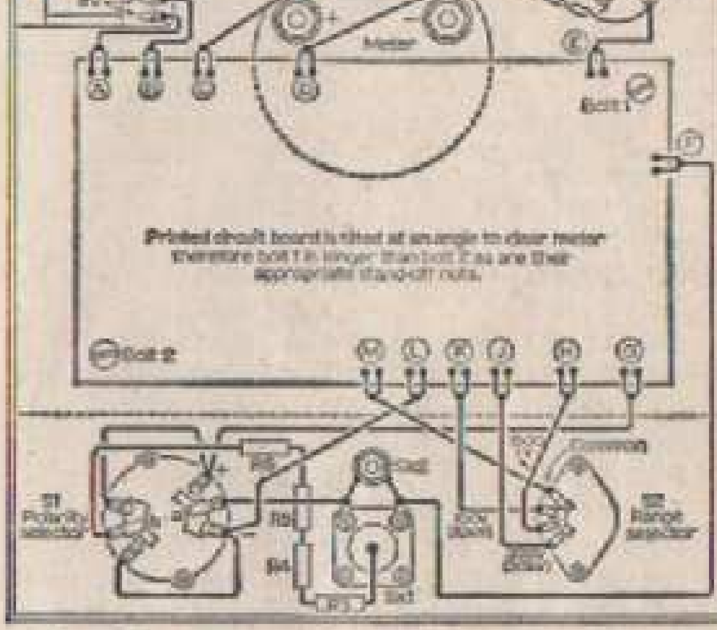


Fig. 3 (above): Constructional details for the e.h.t. probe.

closed and Sk3 withdrawn, i.e. when the meter is being operated on its batteries. To avoid local corona discharge from isolated components when Sk2 connection to the TV receiver chassis is forgotten under these conditions, the casing for the meter unit must be made of substantial bakelite or other approved plastic, *not* of metal.

It is unnecessary to disconnect the mains power section during battery operation. Even if S3 is left on when the mains plug is connected, D5 will isolate the batteries and operation is entirely off the mains. This diode also protects the circuit against accidental insertion of the batteries the wrong way round. Constructors desiring battery operation alone should omit D3, D4, C5, T1, P3, R17 and R18. If mains only operation is desired, omit S3, D5 and the batteries, as the author has done in his prototype. This is a matter of personal taste. With the increasing number of small units accumulating in his workshop, it is difficult to keep track of numerous batteries in individual units and regular replacement and checks are expensive and time-consuming. The practice of making all units mains-operated has therefore been adopted. A single transistorised inverter unit with about 20 watts maximum output at mains voltage and built-in accumulators of the type used in photographic flashlamps has been provided for operating any unit where a mains supply is unavailable.

Fig. 4 (below): Layout diagram of main assemblies showing interconnecting wiring.



VOLTAGE MEASUREMENTS ABOVE CHASSIS

It was mentioned that the meter unit is normally intended for voltage measurements with respect to chassis. No damage or incorrect reading is obtained if Sk2 is connected to some point other than chassis of the equipment being measured, so far as the meter unit is concerned. For making any such measurements, it is merely necessary to ascertain that the point to which Sk2 is connected will tolerate a link to one side of the mains, which may be live, via the high resistors R17 and R18. For example, if Sk1 and Sk2 are to be connected across an anode load resistor in an amplifier stage of the television receiver, take Sk2 to the smoothing or decoupling capacitor and Sk1 to the valve anode, not the other way round. Otherwise hum may be injected to the grid of the next stage via R17/R18 of the meter unit, interfering with subsequent stages of the equipment. If neither side of a component across which the voltage is to be measured will tolerate hum injection, then it is necessary to make sure that Sk3 can only be connected so that R18 goes to the mains neutral: this is good practice anyway, though not essential in general. It is dangerous to insert a switch to break the mains connection from R18 for such purposes, since it may be forgotten in the off setting. Even a pushbutton is not safe, since the mains transformer would be damaged if the chassis connection happened to fall off during e.h.t measurements. For the battery-only version, or during battery operation of a dual-powered unit, there are no limitations on this score. But do not under any circumstances connect Sk2 to any point at a potential in excess of ±500 volts to chassis.

A fuse and or switch may be inserted in the mains lead which is not connected to R18, but it is considered safest practice to avoid a mains switch and fuse altogether inside the unit, and to keep Sk3 two-pin, taking no mains earth into the unit. Mains switching should then be undertaken by inserting and withdrawing Sk3, whilst fuse protection should rely on the normal fuse behind the power point.

VOLTAGE STABILISATION

Whether battery or mains powered, the zener diode D2 in conjunction with R16 stabilises the supply voltage for the amplifier section to 12 volts. Readings are thus independent of mains or battery voltage fluctuations.

SELECTION OF A METER

A very wide range of meter movements are suitable for this circuit. The basic sensitivity should be about 2 to 3 milliamps for full scale deflection, the exact value being unimportant. The value of R15 should be chosen so that it reduces the sensitivity to approximately 4mA full scale deflection. The nearest preferred value resistor is satisfactory. It is clear that the basic sensitivity of the meter must be somewhat greater than 4mA f.s.d. to permit reasonably small values for R15 to give adequate damping. If R15 has to be excessively large, i.e. greater than about twice the meter resistance, the damping will be poor and the pointer will swing about rather a long time before coming to rest for each reading. If a commercial meter movement with built-in shunt for dead-beat damping is used, then R15 is not required externally. The meter should be rated for about 4mA f.s.d. in such cases. Higher meter sensitivities may be used in all cases, but R15 will have to be very small—probably pieces of shunt resistance wire rather than a carbon resistor.

There is no objection to fitting a pair of wanderplug sockets for using an external multimeter switched on to one of its current ranges. If a range of about 4mA (not more) is available on the multimeter, it may be connected directly without fitting R15 in parallel. Otherwise take the next lower range (e.g. 2mA f.s.d. or 2·5mA f.s.d.) and choose R15 to make the effective sensitivity about 4mA f.s.d. One must stand the multimeter on a slab of bakelite and use heavily insulated leads to avoid possible micro-corona damage.

ALIGNMENT INSTRUCTIONS

Before commencing alignment, set VR1, VR2 and VR3 mid-way, VR5 to maximum resistance and after having made sure that the meter is mechanically zeroed, with the unit switched off, switch on and turn-up VR4 until the meter reads 10% of full scale. Now back-off to zero on the scale with the unit still switched on, using the

COMPONENTS LIST

Resistors:

R1	1090MΩ*	R10	10kΩ
R2	72MΩ†	R11	2·2kΩ
R3	10MΩ	R12	470Ω
R4	10MΩ	R13	390kΩ
R5	10MΩ	R14	820Ω (see text)
R6	4·7MΩ	R15	Meter shunt, see text
R7	470kΩ	R16	470Ω
R8	3·9kΩ	R17	5·6MΩ
R9	4·7kΩ	R18	5·6MΩ

* If a resistor of the value specified cannot be obtained that can withstand 30kV, make the resistor up using fifty 22MΩ, ½W, 10% carbon units as suggested in the text.

† The simplest way to achieve 72MΩ is to link four 18MΩ, 1W, 5% carbon units together.

Resistors R3 to R6 are 10%, 1W carbon: resistors R7 to R14 and R16 to R18 are 10%, ½W carbon. In all probability R15 will have to be made, see text.

Potentiometers:

VR1	1MΩ	VR4	1kΩ
VR2	500kΩ	VR5	20 (or 25) kΩ
VR3	100kΩ		

All preset carbon linear pots of the miniature skeleton type.

Capacitors:

C1	1μF, 60V Microfoil
C2	0·22μF, 60V Microfoil
C3	0·1μF, 250V Microfoil
C4	50μF, 35V electrolytic
C5	50μF, 35V electrolytic

Note: C1–C3 may be any other non-electrolytic type, space permitting.

Meter:

M1 Moving coil meter shunted to approximately 4mA f.s.d. (with the help of R15)

Transistors:

Tr1 Germanium low-power audio output type. Example: Mullard OC72.

Tr2–Tr4 Silicon n-p-n types with a current gain of 20 to 30 or better with a collector standing current of 0·1mA. The collector voltage rating should be at least 15V. Examples: General Electric 2N1613 and S.T.C. BSY53.

Diodes:

D1 8V Zener, minimum current rating 5mA.

D2 12V Zener, minimum current rating 50mA.

D3–D5 Silicon rectifiers, minimum rating 500mA, 100 p-i-v.

Switches:

S1 2-pole, changeover, rotary, with pointer knob.

S2 1-pole, three-way, rotary, with pointer knob.

S3 1-pole, on-off, toggle.

Sockets:

Sk1 Large coaxial panel socket (of the transmitting type), 1·5kV minimum rating.

Sk2 Insulated wanderplug socket.

Sk3 2-pin mains connector.

Transformer:

T1 Small bell type, although any mains unit with an 8V secondary will do.

Miscellaneous:

Materials for the printed circuit, wiring and mechanical construction. Two nine volt batteries, PP9 or equivalent.

NOTE: FOR MAINS ONLY OPERATION OMIT S3 AND D5. FOR BATTERY ONLY OPERATION OMIT D3, D4, C5, T1, Sk3, R17 AND R18.

performance specifications

Range	*Input Impedance*	*Current Drain at f.s.d.*
0–100V	360kΩ per volt	3µA
0–300V	120kΩ per volt	8µA
0–1500V	24kΩ per volt	40µA
0–10kV	110kΩ per volt	9µA
0–30kV	36kΩ per volt	28µA

mechanical setting screw on the meter movement. If the range of control is inadequate, open the meter and displace the lower hairspring lever (i.e. the one not engaged by the zeroing screw) in the appropriate direction, so that the screw now gives the correct control range: R14 should be 820Ω for the time being, which value may also prove satisfactory finally. Now switch to the 100V range and apply a known voltage between 80V and 100V. If correct indication is obtained reasonably within the range of VR1, then 820Ω is a suitable final value for R14: otherwise re-select appropriately.

If R14 is changed, switch off, mechanically zero the meter, switch on, advance VR4 to obtain 10% f.s.d., and back-off mechanically to zero again. Note that Tr1 should be bent over to lie adjacent to Tr2, Tr3, Tr4 (but not touching them), to sense the same temperature. Insert a thermometer in this region and cool to 10°C (or less if possible) by directing the air jet from the released valve of a pumped-up bicycle tyre onto the thermometer and transistors. Adjust VR4 for exact zero indication (i.e. would-be 10% f.s.d. if the mechanical zero had not been backed off) at the cold temperature. Now place a small lamp or similar heating device in such a position as to *slowly* raise the temperature of the thermometer and transistors to 40°C (take several minutes). Adjust VR5 to restore exact zero reading at 40°C. Then slowly return to the cold setting, readjusting VR4 if necessary. Repeat this process until no further change is necessary at either point. If any intermediate discrepancy greater than the ±3% tolerance is found, adjust R13 to restore zero at the temperature exactly midway between the extremes.

Now return VR1, VR2 and VR3 to mid-way. Switch to the 1500V f.s.d. range and apply an input voltage of at least 1kV via the h.t. probe. Adjust VR3 for correct reading. Then switch to 300V f.s.d. range and apply a voltage giving near full scale deflection. Adjust VR2 for correct indication. Finally, switch to 100V f.s.d. range and apply a voltage near full scale, adjusting VR1 for correct reading. The order for adjusting VR3 to VR1 must be observed. It is immaterial whether positive, negative or mixed polarity reference voltages are used. Finally repeat adjustments VR3, VR2, VR1 in the same order and manner, since they are slightly interdependent. The meter unit is now aligned correctly for all ranges.

THE H.T. PROBE

The h.t. probe is simply an insulated prod connected to Sk1 via coaxial cable. The important points to be observed in its selection or construction are adequate outer insulation of the prod and cable for 1·5kV working voltage and adequate voltage rating of the coaxial cable and plug fittings (amateur transmitter types). It is necessary to use coaxial cable instead of simple insulated wire because long lengths of unscreened cable connected to Sk1 make the meter unit sensitive to transient kicks from outside interference. Capacitors C1, C2, C3, certainly remove steady injected a.c. components, but cannot cope with sudden fluctuations, which are passed on to the meter as transient kicks. The e.h.t probe must be fitted with coaxial cable for similar reasons

THE E.H.T. PROBE

Safety for the operator is assured by making this probe of adequate length and building it with high-insulation plastic in the manner sketched in Fig. 3, whereby the large series resistors totalling over 1000MΩ are placed in the body as shown. The probe actually used by the author was purchased ready made for his large VTVM installed permanently in the laboratory. This VTVM is too cumbersome to take on field work, but it was considered convenient to design the transistorised e.h.t. meter for the same probes. This commercial e.h.t. probe contains a special single resistor of value 1090MΩ (±3%) expressly rated for 30kV. If such a component is available, it may be used. Otherwise fifty carbon resistors of 22MΩ value must be connected in series as indicated in Fig. 5. Resistor R2 is essential to prevent micro-corona across the insulation of the coaxial cable if the e.h.t. probe is touched onto a final anode when it has been forgotten to connect it to Sk1 on the meter unit.

PRINTED CIRCUIT BOARD

Parts of the circuit on this board carry potentials of several hundred volts. Thus ensure clean etching and processing, with adequate spacing of the conductors. Also remember to apply a coat of insulating varnish as supplied for printed circuits, after all wiring is complete. The resistors R3, R4, R5, R6 are seen to be strung in the external wiring, not on the printed circuit board. Do not use a smaller number of higher value resistors, since up to 1·5kV is developed across them during operation: so distribution thereof over several resistors is essential to avoid early breakdown. Make sure that these resistors are mounted *rigidly* and that they are well-clear of other wiring. Use transmitter-type coaxial fittings. ■

UNDERNEATH THE DIPOLE

SHOP! SHOP!! You can't get away from it, can you? At any rate, in all the various sides of show biz, artistic or technical, they rarely seem to talk about anything else but *shop!*

Getting together

When technicians from television and film studios huddle together in clubs and pubs, you can bet dollars to doughnuts that they will be talking about *colour:* its unpredictability, its fascination, its future. There are significant signs that the production sides of the cinema and the television industries are drawing closer together. The informal discussions and arguments of individual technicians are rapidly developing into the more formal lectures and debates of their technical societies or by articles in their journals. Seminars about lighting for colour have been organised by Strand Electric, Mole Richardson and others in addition to those organised by the Royal Television Society, the I.E.E., the Society for Film and Television Arts and the British Kinematograph, Sound and Television Society. In spite of the enormous cost of colour television production, transmission and reception, it will soon be as much a part of our lives as coloured holiday snaps and movies, or highly coloured newspaper-magazines.

The mysteries of B and W

Delicate colours in costumes, wallpapers and furniture which look delightful on colour television sometimes look just drab and dull on black and white TV receivers. Certain shades of pink, green and yellow, for instance, may have a delightful colour separation which is entirely lost in b and w reproduction; all of them might have exactly the same grey-scale value. A multi-coloured frock can be reproduced as though it had the same overall shade or colour. Also, faces which have satisfactory skin tones in colour may reproduce darker or lighter than is acceptable when they are backed by the wrong wallpaper. Underlit low-key lighting that may be passable in colour, due to colour separation, but when seen on a b and w receiver, may look like a jumble of shadows. As for the reproduction of *avant-garde* paintings, the black-and-white version may even deepen one mystery of whether they are upside down or not.

Coloured telecine

Lighting cameramen, make-up artists, art directors, costume designers, set dressers and scenic artists will all have to learn the problems arising from the two end-products: coloured pictures and black and white. It is becoming rapidly obvious that coloured telecine equipment will be an important asset for film studios which make colour film series specifically for television. Each day's shooting in a film studio is seen next day mainly with black-and-white film prints together with colour pilots of each "slate" together with colour prints of one or two complete selected scenes. It would be a good safeguard to show these coloured pilots by telecine with three TV monitors side by side: (a) a colour monitor (b) a good black-and-white monitor and (c) domestic receiver. Film crews ought to see their work on these television monitors as well as on the cinema screen.

Television studios which record their plays and series on tape in colour are now able to obtain excellent colour reproduction. Therefore the technical crews should be provided with the same triple monitor viewing facilities. Good though the colour results are, there is the line standard barrier when considering the use of such tapes for the world-market.

The TV world is now divided by the differences between 50 cycle a.c. mains with 625 lines (and 405) on the one hand and the other nations with 60 cycle mains and 525 lines, not to mention the encoding systems N.T.S.C., P.A.L. and S.E.C.A.M. Every effort is now being made to transfer magnetic videotape vision and sound recordings to 35mm., 16mm., and even to Super 8 film. This has been accomplished by the recently established Vidtronics Division of the Technicolor Corporation and already achieved on the 16mm. colour film. The electronic colour information from the tape is separated into its yellow, cyan and magenta components which are photographed on three colour separation film negatives, from which are derived the dye-transfer facilities for release printing of many copies in Technicolor.

Credit—where credit's due

Are credits a waste of time? I refer to the detailed lists of directors, art directors, make-up artists, wardrobe, lighting directors, camera operators, uncle-Tom-Cobley and all? Do viewers care passionately who was the continuity girl, who did the special effects or who dubbed the sound? Ah! But he *would* like to know who acted what, who wrote it and who directed—I think.

I would be a strong advocate for credits, both for actors and for technicians—providing the viewer was given time to read them easily, without disturbing background flashes and "jump cuts" or loud brash musical discords. For example, everyone knows who the stars are of *The Avengers;* but without keen eyes it is difficult to see who the excellent supporting actors are—unless you know them by sight, anyway!

In the case of those very old

Hollywood films, a cast list can make some fascinating reading. I recall one Hollywood musical where one of the smallest parts was played by Mike Frankovitch, who is now boss of the giant Columbia Pictures Corporation. There are the old English pictures too, with their small parts played by today's acting "Establishment" — all cinema films pay no replaying fees to actors who made them for a different medium. So there is quite an astonishing situation where the commercial TV actor with perhaps a single shot of him eating a bar of chocolate gets an extra fee each time it is shown! Compare this with the same actor in a cinema classic appearing time and time again without getting a penny by way of royalties!

Iconos

The latest James Bond film "You only live twice", to be released in the autumn, is also to include electronic gadgetry. This time a television control centre, bristling with all the latest gear, in the side of a volcano. The photograph—wait for it, it's classified information—was taken at Pinewood Studios.

TRADE NEWS • TRADE NEWS • TRADE NEWS TRADE NEWS • TRADE NEWS • TRADE NEWS

PANEL LIGHTS TO ELECTRIC ORGANS

FROM Henry's Radio Ltd. comes the 1967 Electronic Components, Equipment and High Fidelity Catalogue. This edition—now over 200 pages—is more comprehensive than those published in previous years and includes details of many new items supplied by Henry's, including their Mayfair Portable Electronic Organ.

Included in this issue are five free discount vouchers which when used enable the customer to obtain 2s. in the pound discount. It is also interesting to note that further discounts are allowed for equipment in the Hi-Fi section of the catalogue.

The price of the catalogue is 7s. 6d. plus 1s. postage and copies may be obtained from Henry's Radio Ltd., 303 Edgware Road, London, W2.

SUB-MINIATURE METER

SIFAM Electrical Instrument Co. Ltd., Woodland Road, Torquay, Devon, have introduced a new, sub-miniature, instrument in their "Director" series of moving-coil electrical measuring instruments.

The new "Director 14" is exceptionally compact, having an overall size of 1·92in. by 1·65in. with a scale length of 1·34in. It is a flush mounting instrument requiring a panel cut out of only 1·5in. diameter.

The case is made from a special reinforced plastic with a matt black finish, resulting in an elegant yet highly practical case style, which blends well with modern equipment panels.

NEW TAPES FOR HELICAL SCAN V.T.R.'s

TWO new magnetic tapes for helical scan video recorders have been introduced by the 3M Company. Designed, tested and proved on commercially available video recording equipment, the new tapes offer users significant advances in performance.

The two new Scotch video tapes, types 350 and 351, are highly resistant to wear, have low tape noise and low drop-out.

An improved binder formulation is incorporated, which is a feature of the highly successful Scotch tape 399 designed for use with quadrature video recorders. This introduces to users of helical scan recorders some of the capabilities of quadrature recording machines. The high conductivity coating makes for efficient heat dissipation and ensures long tape life and minimum static build-up. 3M say that these tapes are the cleanest running tapes ever produced with minimum rub-off.

Type 351 has a 1 mil. polyester backing with 210μin. oxide coating. It is available in ½in. and 1in. widths. Type 350 also employs a 1 mil. polyester backing with 450μin. oxide coating and is manufactured in 1in. and 2in. widths.

625 LINES IN 405 CHANNELS

A. O. Hopkins

Visible structure loses one-third of the picture — Part 1

OUR 405-line television service has been condemned by the Television Advisory Committee as unfit for colour and the Goverment has decided that 625 lines are essential for future TV services. This means an 80% increase in video bandwidth to accommodate the extra lines (50% more); the video bandwidth having to be increased from 3Mc/s to 5·5Mc/s for 625-line broadcasts.

Although circuitry for television transmission and reception has been perfected, thanks to modern science, no new discovery in physical optics has been applied to TV picture formation since 'twin-interlaced' scanning halved the vision bandwidth for our 'high definition' service which began in 1936. The line structure just visible on early receiver screens (diameters from 6 to 10in.) was expected to be too prominent for 12in. screens! Yet, instead of trying to remove the scanning fault which separates the traced lines, more lines were advocated as a remedy. After the war, with screen diameters increasing and with lines more brilliant in contrast with the unscanned grid, efforts were made to hide the fault, by spot wobble, spot elongation and attachable screens. Twenty years later the line-structure, though finer, can still be seen on 625-line pictures despite nearly twice the bandwidth.

How the eye sees TV pictures

At the recommended viewing distance, the 405-line structure is lost, but so is most of the definition. No remedy for the transmitted fault can be found until unsound ideas are discarded. At the cinema 24 'stills' are flashed on to the screen 48 times per second, showing each twice. The flash speed is copied for TV scanning (by 50 frame sweeps); flicker is generated by the short persistence screen phosphor. Each 'still' is a complete picture; copied by telecine our 405-line picture is incomplete because the interlaced lines do not touch.

Since the fault is optical no remedy can be devised without knowledge of how the human eye functions when viewing a TV screen. Figure 1 is a greatly simplified diagram of an eye in section. Light rays enter the lens system (Cornea C, Pupil P and Optic Lens L) which focuses them to an inverted image on Retina R, the exposed surface of which consists of some millions of nerve-ends, the 'rod' and 'cone' photo-receptors. Each receptor reacts to the light point striking it in proportion to the brightness, and applies impulses to the Optic Nerve ON for transmission to the sensorium of the brain.

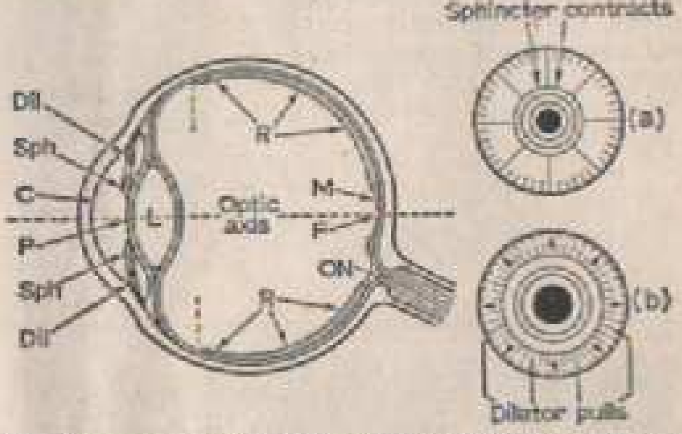


Fig 1: Cornea C. Pupil P. Optic Lens L. Optic Nerve ON "blind spot". Retina R. R receives image: good definition at Macula M with Fovea F at centre. Iris muscles vary pupil size: (a) bright light: Sphincter (Sph) contracts toward Optic Axis. (b) Poor light: Dilator (Dil) pulls pupil open (as arrowed).

Near the centre of R is Macula M, the 'yellow spot' where 'cone' receptors are closely packed. Wherever we look we do not see the whole scene clearly; the simple bi-convex Optic Lens can only focus sharply at the Macula, and only in the central Fovea F does the image in each eye coincide exactly with the other. Parallex, caused by the separated viewpoints of the eyes, presents two 'pictures' which differ progressively away from the two Foveas. (Anaglyph pictures rely on this view-point difference for their 3-D effect). Only the cones differentiate colour clearly, but corner of eye movement is detected by the 'rods'. The illusion of movement in the image is caused by change of light on some receptors, in contrast with unchanging light patterns elsewhere.

Flicker

The Iris, the coloured area surrounding the Pupil, consists of two concentric rings of muscle which control the aperture. At (a) Sphincter (Sph) contracts reducing the pupil; at (b) Dilator (Dil) pulls the pupil open. The sharpness of the image varies with the aperture, as in photography: bright scene, pupil small, clear details; poor light, pupil dilated, details diffused.

The Iris must also protect the minute receptors from excessive light. A sudden flash on them jolts the Optic Nerve to react: the Dilator slackens, the Sphincter tightens; this contracts the pupil until it cuts down the light on the Retina to a safe level. Sudden darkness reverses the action, causing the pupil to 'dilate'. This 'push-pull' of the Iris muscles is painful if the alternation is slow. As the flash frequency increases inertia reduces the extent of aperture change; the pupil remains set halfway between the alternations as the frequency approaches 50. Flicker and persistence of vision are unrelated, since they concern parts of the eye which act independently.

Persistence of vision

The TV receiver-screen phosphor, struck by the point of the electron beam, flashes to brilliance almost instantaneously, and the flash strikes the Retina with the speed of light, as shown in Fig. 2, where flash and visual reception curves start at the same zero point. The phosphor response rises sharply to peak A from which it falls, leveling off to a weak afterglow.

The receptors do not immediately respond to the light, and the Optic Nerve also takes time to transmit the sensation, represented by the delayed rise to B, in less than 1/100 second. The receptors lit by the flashed image are sustained in activation by fluid (the 'visual purple') surrounding them. This persistence of vision lasts without visible weakening for about 1/15 second, as at C, after which it fades gradually, becoming weak after about 1/10 second.

It is obvious that the best point to renew the flash is at C; for the perfected 'silent' film of the cinema the renewal speed was fixed at 16, as at D. The Baird low-definition TV system, which could only spare 12½ pictures as at E, sustained pictorial movement quite well; flicker was the trouble, caused by the low flash frequency, not the low renewal rate. Early motion pictures had the same flicker trouble until the projection to the screen of each of the 16 'stills' was chopped 3 times, raising the flash frequency to 48.

Why 25 pictures?

Our present TV pictures are renewed 25 times, as at F, which is clearly excessive because no visual advantage is gained between F and D. This premature renewal of traced lines, still visually active, wastes bandwidth; the line total is reduced, and so is picture quality because the lines cannot touch. It was thought that telecine would require each traced picture to match a film 'still' (speeded from 24 to 25). In fact, interlacing frames are not tied to a particular film or TV picture. The scientifically chosen 16-frame speed for intermittent film was suddenly abandoned by the film industry because the original rather crude optical sound-track of the early 'talkies' was too coarse to record within the height of the relevant frame. Instead of refining the 'sound' system until it fitted the film, frame renewal was increased to 24 per second solely to accommodate the added track. Later the noise ratio was improved, and magnetic recording introduced, but not an inch of film was saved.

In all other 'audio' media, including radio, disc and tape, efficiency and fidelity have improved with reduction in physical size. Modern invention, which has miniaturised stylus tracks and amplifier circuitry, is available to compress the oversize track into the number of film-frames adequate for visual persistence: sixteen. The cinema sound-track remains pre-transistor, 78 r.p.m. in fact!

Perhaps the film industry can afford to increase the bulk and cost of film stock by 50% without reason. Television certainly cannot afford to continue wasting one-third of every vision channel.

Our "two-thirds" picture

How much of our TV picture is lost between the cracks? The thickness of the separated lines, relative to the strips of screen they are trying to cover, can be checked on any receiver by reducing Picture Height until the traced lines touch. The 'wide screen' shaped picture is much brighter, and about one-third of the screen is left unscanned, partly above and partly below the compressed picture. This loss of one-third of the picture can only have one of two causes: (1) the scanning point is too small, or (2) the lines are too few by about one-third.

Another quick test answer to (1): restore picture height, and then by the focus control enlarge the scanning point until the traced lines again touch. The 'structure' disappears, and so does definition! Restore the focus and see the details reappear along the traced lines, proving that scanning point size on our 405 screen is correct for the 3Mc/s bandwidth. This gives us

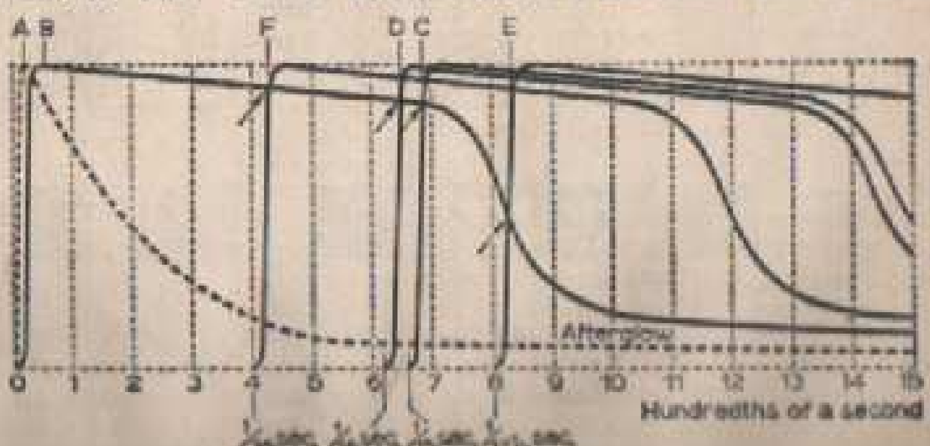


Fig. 2: Visual persistence, following flash at A, is sustained from B to C. Ideal renewal at C. Renewal speeds (succession of flashed pictures) as employed for: 16-frame film at D. "Low definition" TV at E. "Twin-interlaced" scanning at F. Arrows show that renewal prior to C or D is premature.

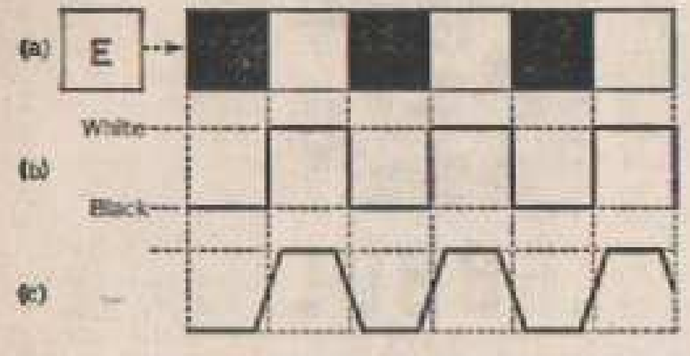


Fig. 3: Elemental "chess-board" diagram with element-size scanning point E. (a) Part of one scanned line. Photo-electric wave-forms. (b) Ideal. (c) Early idea of "aperture effect" distortion when scanned by E.

the answer to (2): one-third of the lines are missing. Our 400-line picture is really two-thirds of a 600-line picture.

Scanning fallacies

Our two simple experiments reveal a serious inconsistency between spot size, line pitch and line total. Definition along the traced lines is excellent, but they are badly distributed and prematurely renewed; 'television standard' planning must be at fault; the vertical dimension is both under—and over—scanned. The unit for current bandwidth calculation is the 'picture element', and it is believed that two contrasting 'elements' can be formed by the element-size scanning point within one cycle at maximum video frequency. Paul Nipkow visualised scanning in 1883, but his theory was not put into practice until the 1920's, using his apertured disc; 'low definition' pictures of 30 contiguous lines were traced by a spiral of element-size apertures through which the glow from a discharge lamp flashed. Later mirror drums projected larger pictures, but the lines were too few, and flicker speed (12½) too low, although pictorial movement was acceptable. 'Aperture effect' was blamed for diffusion along the lines, but how could 26,000 'picture elements' (needing 13kc/s) be transmitted on a 9kc/s M.W. channel?

Scanning theory and practice

By 'element' theory the screen can be represented as a chess-board of square units. One line of 'element' is shown in Fig. 3a, with element-size spot E about to scan them: at the camera to analyse, at the receiver to reproduce them. E fails to achieve the ideal photo-electric wave-form at (b), or even the flat-top response at (c) which would give negligible diffusion.

The c.r. tube, multipling the lines into hundreds, took over from mechanical systems, but also inherited their scanning theory. 'High definition' TV was allowed a 3Mc/s channel, which 'element' theory divides into 25 'picture' renewals of 405 lines. Despite theory, at camera and receiver (with line total and scanning pitch fixed) resolution of details could not be obtained until the scanning point was reduced well below 'element' size. This breakthrough to definition was never claimed, and the separation of the contracted lines was also ignored. It was not realised that a scanning point as large as an element cannot extricate itself between elements, and must blur each into its two neighbours along the line.

The 'element' fallacy remained unchallenged; 'raster' a new technical word, fostering the idea that TV pictures must show lines, seems to condone visible scanning structure. Fig. 4 shows a row of ten mixed elements (white, grey, black) at (a), again with E scanning them. At (b) the weakly-peaked waveform confirms the poor resolution shown by our defocusing test. E spans three adjacent elements to trace the centre one; for example E starts at S while still within 1, and does not leave 2 until F, within 3. This triple blur diffuses every element; some disappear as does Grey 5 (between White 4, Black 6), most are reproduced with false values as Grey 8 (too light).

Half-element spot

Our 'compression' test proves that the lines are only 2/3-element thick, which is the diameter of the scanning point which traces them. This makes the spot area about one-half elemental (4/9). Our TV picture is being traced at elemental pitch with a half-element spot! TV 'brickwork' is planned

—continued on page 371

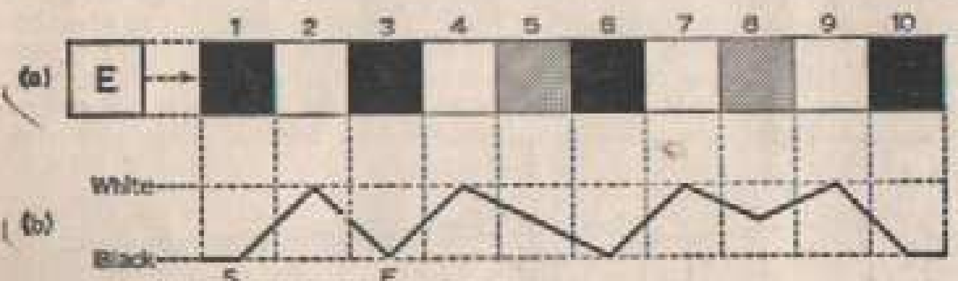


Fig. 4: (a) Line of "picture elements" of three different light values (white, mid-grey, black). (b) Actual photo-electric wave-form if scanned by element-size point E. To trace element 2 E starts at S (in 1), finishes at F (in 3) diffusing all three elements. Note complete loss of "black" and "white" (ineffective peaks), and of Grey 5.

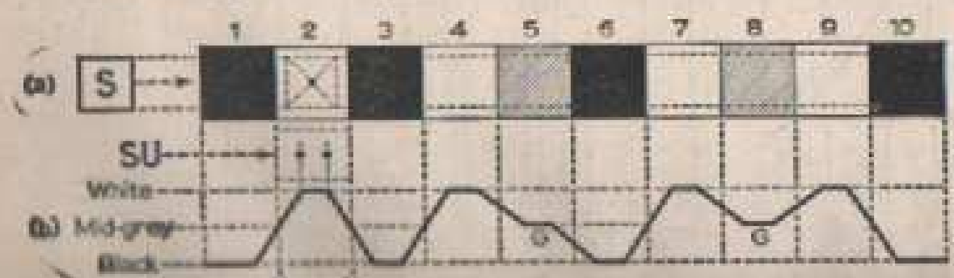


Fig. 5: (a) Line of "picture elements" (white, mid-grey, [illegible]) scanned by practical half-eleme[illegible] point S, in general use in receivers with correct focus. (b) The focused point extricates itself between elements, X to X, to form an individual Scan Unit as at SU for each of them. Photo-electric wave-form shows correct light levels, including G for Greys 5 and 8.

WIDE-RANGE WOBBULATOR

D.R.BOWMAN B. Sc. A.M.I.E.R.E.

PART II *continued from the March issue*

In assembling, leave the positioning of the inductors until all the components have been assembled on to the circuit board, to avoid damage. To minimise unwanted coupling between the inductors, they are mounted on alternate sides of the circuit board; if L3a is above the board, the adjacent L4a is placed below, the next L4a above and the following L3b below. If this is done, screening becomes unnecessary.

The filter capacitors are preferably to 2% tolerance or better, and certainly should be no worse than 10% tolerance. If a bridge is available for measurement, the values of the 33pF capacitors can be picked from stock at 32pF, and the 100pF capacitor at 101pF. The remaining components can be 20% tolerance or better. It is not necessary to earth the case of the OC171 transistors. Two holes are cut in the board so that it can be bolted to a strip of aluminium, bent up suitably, and this strip will afford the means of mounting the circuit inside the can. The —ve supply is brought into the can by way of a 1000pF lead-through capacitor. Fig. 4 shows the method of assembly.

The cans containing filter, oscillators 1 and 2, are all mounted in a similar way on a metal sheet which forms the common chassis and the +ve supply lead. Because the decoupling lead-through capacitors and some wiring poke through, it would be unsightly to use this sheet as the instrument front panel. It is therefore mounted, by means of four studs, about ¼in. behind the front instrument panel; and spindles, switch knobs and so on are readily arranged to be accessible from the front panel when the instrument is assembled.

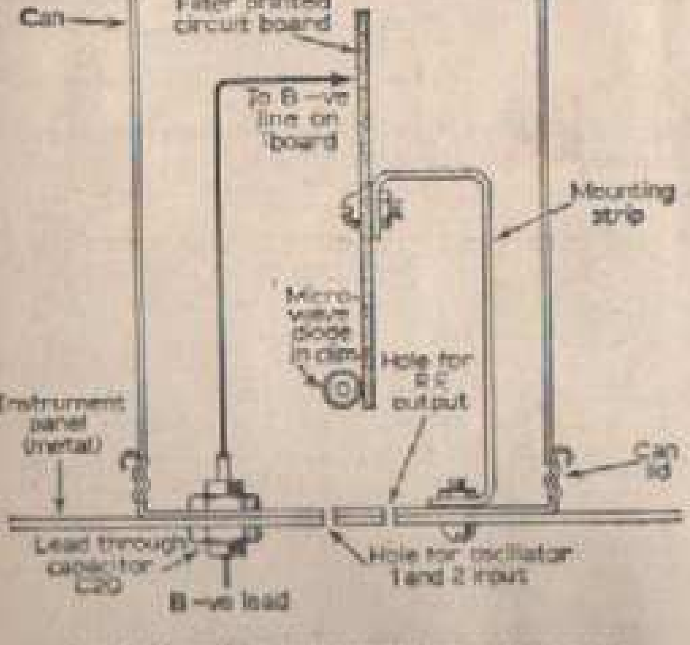


Fig. 4: Mixer/filter arrangement in screening can.

Oscillator 1 and the reactance diode are mounted in a similar way to the filter. In this case a smaller can may be used, and the prototype employed an aluminium can 1¼in. diameter and 2¼in. long. Battery —ve and sawtooth supplies are led in through 1000pF lead-through capacitors.

Printed circuit board

The suggested printed circuit board is illustrated in Fig. 5, measures 1¾in. by 2in., and is mounted vertically as in the case of the filter. L2 consists of 3 turns No. 18 s.w.g. on a polystyrene former a little over ¼in. diameter, spaced to occupy 3/16in. winding length. It is tuned by means of a brass slug—OBA threaded rod is excellent and may be cut into pieces ⅜in. length for the purpose. If the wire is wound on a ¼in. drill shank it will fit tightly on to the former and may be secured either by very lightly damping the former with toluene and allowing to dry, or with a little contact adhesive. The tuning slug can be made tight to turn with a little plasticene or a strand of elastic rubber. The coil can be mounted parallel to the circuit board so that it may be tuned via a ¼in. hole cut through the can lid and the metal sheet on which it is mounted.

Oscillator 2

Oscillator 2 has a similar circuit, but since a variable capacitor is used for tuning it, the circuit board is arranged differently. A Jackson Bros. capacitor, 2-10pF, is used and this has long lugs protruding from the stator plates, one of which can be used to help support the circular circuit board about ¾in. above the top surface of the capacitor. The mechanical arrangement is shown in Fig. 6, where another aluminium can 1¾in. diameter and 2¼in. long is used for screening.

Fig. 7 shows the suggested printed circuit board for this oscillator. The coil L1 consists of 2½ turns of 18 s.w.g. enamelled copper wire on a polystyrene former (as in the case of the other

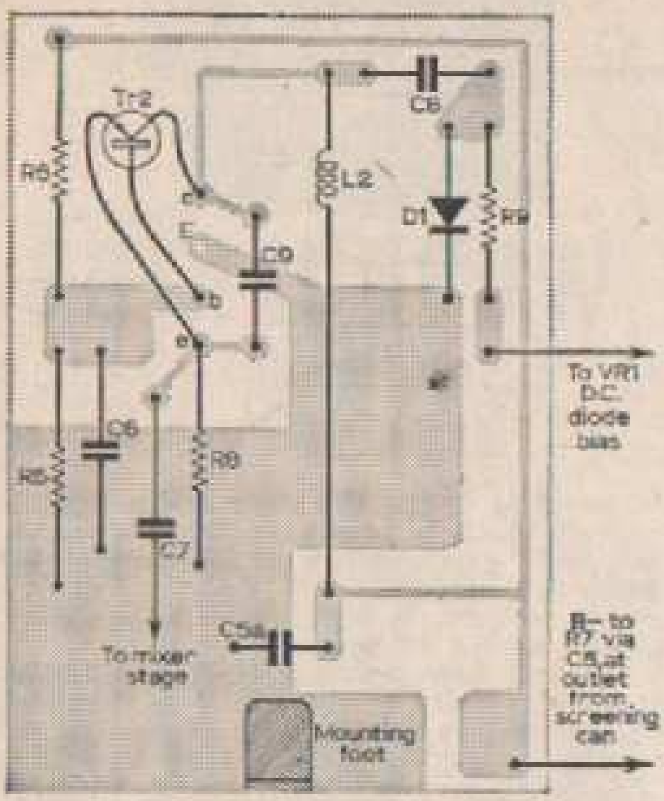


Fig. 5: Oscillator 1 printed circuit board.

oscillator), the turns being spaced to occupy 5/32in. measured at its maximum. It is also tuned by a brass slug, but the can itself, not the lid, must bear a central ¼in. hole so that the slug can be rotated. The transistor is another AF102. For both oscillators the transistor leads are standardised by clipping off to leave ¼in. of wire.

There is no special way in which the three cans need be mounted on the common chassis, except to arrange matters so that the "hot" leads are as short as possible. These leads are, of course, the wires from the oscillators carrying v.h.f., and the lead from the filter output carrying the difference frequency, although the latter is best carried by miniature low loss 80Ω coaxial cable now available. It is quite flexible and convenient in use, although terminations are best prepared with a watchmaker's lens in one eye.

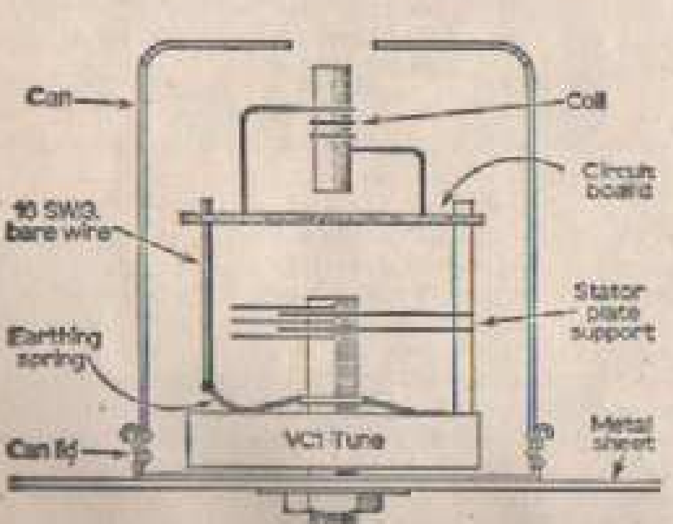


Fig. 6: Oscillator 2 assembly. Note the positioning of the printed circuit board and coil L1.

The leads for battery supply and sweep voltage may, of course, be arranged as convenient, and there is no need to screen the d.c. diode bias potentiometer or the sweep amplitude control—nor for that matter, the r.f. output potentiometer. It is important that the latter component is not of the wire-wound variety, as the inductance is high and affects the operation of the control very adversely. Carbon-track potentiometers are available in the value required.

A certain amount of setting-up is required, but is not difficult. Alternative methods have been used and both found effective, so both will be described. It will be necessary first of all to ensure that both oscillators work, although if correctly constructed this might be taken for granted. It will be easy to detect oscillation if the cans are taken off the oscillators, using either a v.h.f. receiver or a TV receiver tuned to Band III as the detector. Radiation will beat with receiver oscillator harmonics and some plops will be heard in the loudspeaker as tuning is effected. Once this is established the can may be replaced.

The first method of setting-up is a little rough and ready, but works. The tuning capacitor of oscillator 2 is set very nearly to its maximum capacitance position, and the tuning slug for this oscillator is adjusted so that it is barely within the inductor L1. The r.f. output control is set at maximum and the output lead taken to the aerial input of a medium-wave receiver. The tuning slug of oscillator 1 is withdrawn and the d.c. diode bias set to mid-range.

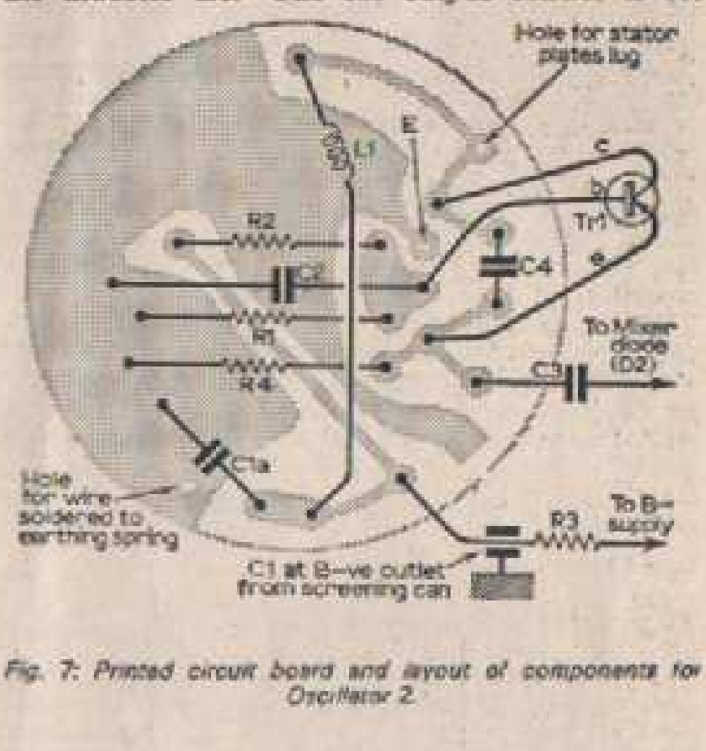


Fig. 7: Printed circuit board and layout of components for Oscillator 2.

The medium-wave receiver is switched on and the volume turned up so that noise is heard. Then the tuning slug of oscillator 1 is carefully screwed in, until a carrier is heard in the receiver. If the tuning of the latter is for 200m (or 1·5Mc/s), it is now known that this oscillator difference frequency is 1·5Mc/s. The tuning capacitor of oscillator 2 may now be adjusted to give, say, 10·7Mc/s, difference frequency, the setting being determined by feeding the output into the i.f. amplifier of a v.h.f. receiver. In fact, it can be

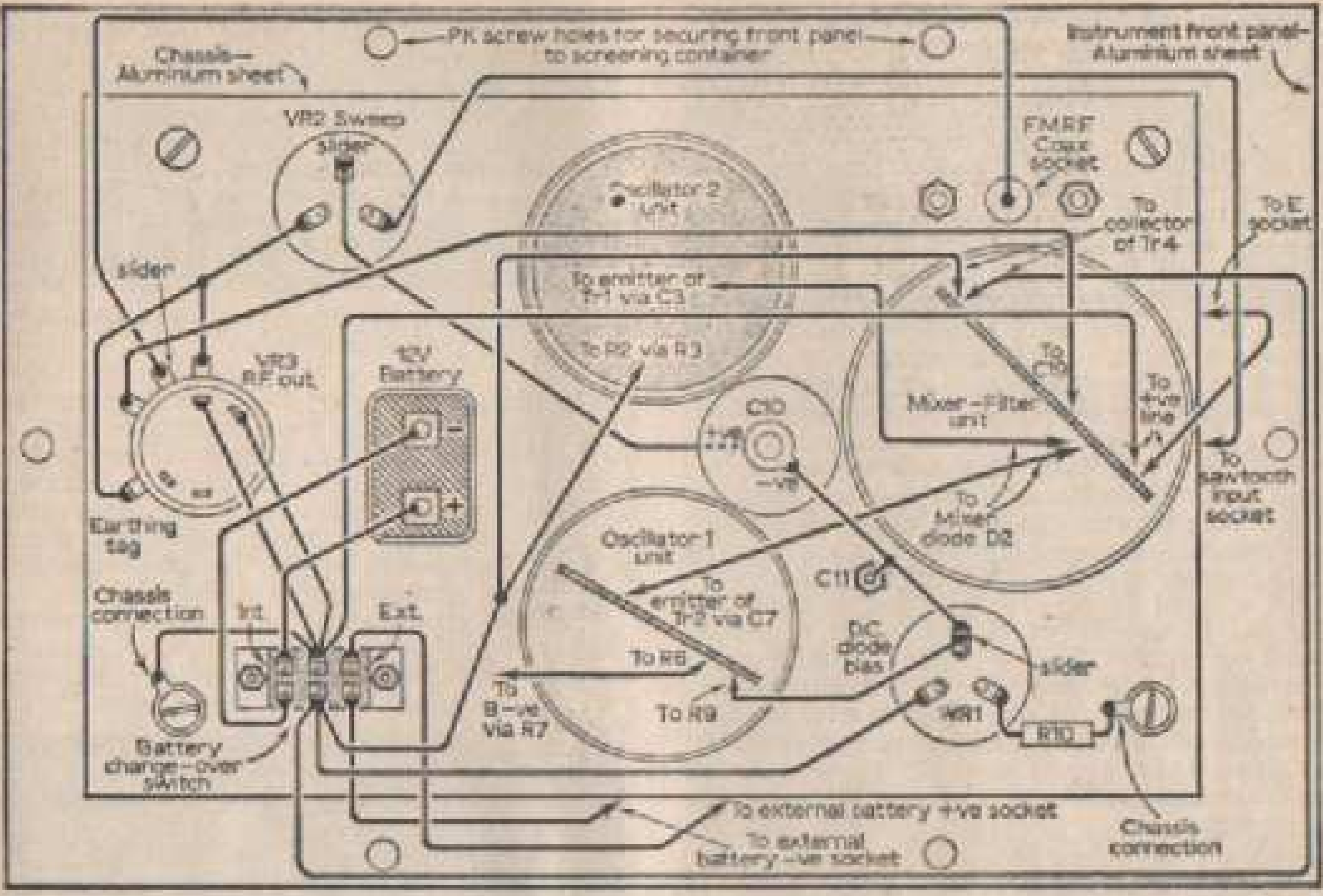


Fig. 8. Diagram showing layout and main wiring of the wobbulator. Note that the mixer/filter unit is mounted on one printed circuit board (see fig. 3). See further notes at end of this article.

applied to the aerial socket, relying on breakthrough to get to the i.f. amplifier. If this is done, however, one must expect to hear spurious responses; v.h.f. is not entirely eliminated by the filter, and receiver amplification will be high. However, when the i.f. is actually achieved the noise will still be heard if the receiver tuning is changed, whereas spurious signals tune out. A further similar check can be done with a TV receiver, to find the setting for the i.f. of the TV receiver, 38·15Mc/s as a rule for 405-line operation.

Frequency check

The alternative method is to use an absorption or receiver-type wavemeter to set both oscillators to the same frequency, the tuning capacitor of oscillator 2 being in the maximum capacitance position. If no such instrument is available, a v.h.f. receiver may be used instead as follows. This account is an example, and should be modified appropriately if the v.h.f. receiver does not have the characteristics of the example.

Suppose the v.h.f. receiver has an intermediate frequency of 10·7Mc/s and the oscillator frequency is *above* the signal frequency. If the receiver is set to 85Mc/s, the oscillator will operate at 95·7Mc/s and a harmonic will lie on 191·4Mc/s. If the oscillators are adjusted in turn to this frequency, their difference frequency will be zero, and tuning of oscillator 1 will change the output frequency as required. Adjustment to 191·4Mc/s may, however, require that the diode bias has to be increased, and this will impair the frequency sweep. If the v.h.f. receiver operates with oscillator *below* the signal frequency setting of 85Mc/s, this will result in the oscillator fundamental being at 74·3Mc/s and a harmonic at 148·6Mc/s. This is very close to the design frequency of 150Mc/s.

It will be realised that calibration of the tuned oscillator for difference-frequency output is hardly possible unless the d.c. diode bias of oscillator 2 is fixed, since the d.c. bias can be used to cause wide variations of the oscillator frequency. If this is desired, the 250kΩ potentiometer concerned should be so placed as to be "non-adjustable by the user" or replaced by a couple of fixed resistors, whose junction is connected to the 100kΩ resistor. These resistors could be of value 68kΩ (going to +ve supply rail) and 150kΩ (going to the −ve supply rail). In such circumstances it will be advisable to settle for a −ve supply of −10 volts, using a series resistor in the −ve supply and a zener diode to stabilise the supply voltage. This will necessarily increase to total consumption of the unit from 6·5mA to at least 10mA. A 220Ω series resistor would be appropriate.

However, calibration is not the most necessary feature of this instrument; the object is to get a wide and controllable sweep. In the prototype the sweep achieved is at least 20Mc/s with difference frequency set at 35Mc/s; that is, the frequency generated varies from 25 to 45Mc/s. This is not often used, naturally. The sawtooth voltage required for this sweep is about ±2 volts, and is taken from the writer's oscilloscope (the X time base generator).

Rule of thumb

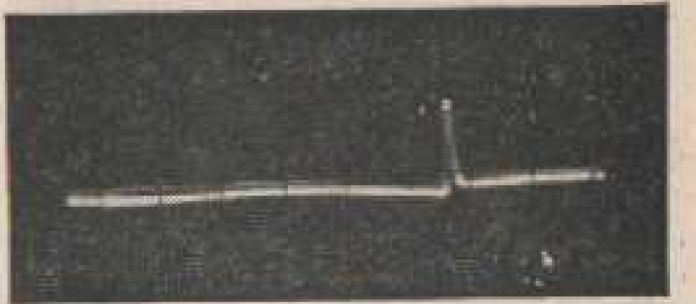
A good rule of thumb is that the speed of frequency sweep should be less than one thousandth of the bandwidth of the amplifier under test. Thus, with a TV receiver of vision i.f. bandwidth 3Mc/s the X time base generator speed should not exceed 3kc/s, while the testing of a v.h.f. receiver of i.f. bandwidth 300kc/s should not be done with time base speeds exceeding 300 sweeps per second. In general, very low speeds are used, about 50—100c/s, with every satisfaction. If the output is monitored aurally, as is often the case, the low note is moreover not as objectionable as a high-frequency loudspeaker output. However, for testing a medium-wave superhet of i.f. bandwidth 10kc/s a speed of 50 sweeps/second is really too high, and 10 sweeps per second should be chosen instead—or a little faster if flicker is found to be objectionable. At such output frequencies (say 1·5Mc/s) jitter begins to be objectionable, although the device can produce useful results if employed with care. Only a mere trace of sawtooth voltage should be applied, however, or else the trace will be so narrow as to be hardly visible and the inevitable jitter will further impair results.

The prototype is arranged so that either internal batteries or an external supply can be used at will. Input sockets for this facility are provided, selection being by a slide type switch.

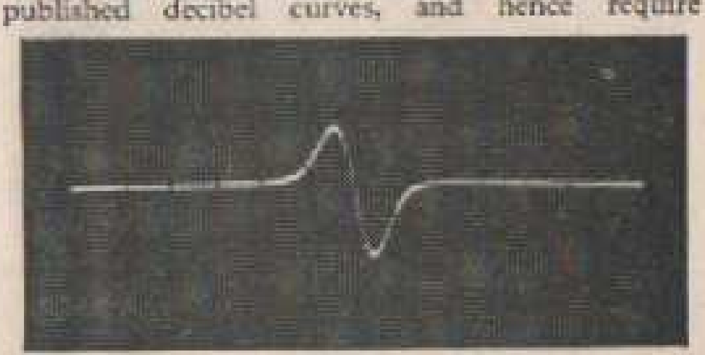
Stray radiation from the instrument cannot be detected whether internal or external batteries are used. This prevents annoyance to neighbours and minimises interference with one's own equipment.

Control of gain

To use the device effectively it is necessary to ensure that the overall gain of the receiver and X amplifier of the oscilloscope is such as to produce a voltage at the deflector plates of about 10V. If the spot is especially finely focused, it may be possible to do with much less, but 10V represents a good average figure. If the X-amplifier has a gain of 100, 100mV at the X input will be required. The usual i.f. amplifier has a gain of some 10^5, so that an input from the wobbulator of 1µV will be required, if the i.f. amplifier is fed straight into a detector. This is readily available, but if the i.f. amplifier gain is much below 10^5 it may be desirable to interpose a good a.f. amplifier between the amplifier under test and the X input terminal. Attention must be paid to low-frequency response, and coupling capacitor-resistor time constants should be of the order of seconds. A transistor amplifier would require a base-coupling capacitor of some 500µF for best results, unless a high-input impedance arrangement, such as a "Darlington pair", is used. Since the collector feeds into the high input impedance of the X amplifier, much lower values of coupling capacitor may be used in this position, 2—10µF being normally sufficient. Transformers will inevitably produce distortion or ringing, and should not be employed; in particular if output is taken from loudspeaker terminals each "wobbulation" will be followed by a damped train of waves arising from loudspeaker cone vibrations. This may readily be shown by damping the cone with a finger. This does not always apply—for example if heavy negative feedback is used in the a.f. amplifier to increase loudspeaker damping.


Response curve of a transistor portable. Bandwidth 4·5kc/s i.f. 470kc/s.

The photographs show some of the i.f. response curves obtained with the prototype. It should be noted that these are voltage curves, not the usually-published decibel curves, and hence require interpretation mentally when being used to judge the performance of amplifiers. The base line is zero response, or minus infinity with respect to the top of the curve. Hence one must imagine the skirts of the response curve multiplied logarithmically, as it were, if one wants to fit the whole curve into the more familiar decibel style. If one considers only the tips of the curves a better idea can be gained. Half-way down from the top is −6dB, 30% from the top is −3dB, and so on. Thus the curve as displayed is definitely peakier—more triangular—than the equivalent dB curve. It is only a question of familiarity, and one soon gets used to the idea of voltages instead of decibels. An exception is the case of the f.m. detector (discriminator) output;


Response curve (discriminator) of v.h.f. transistor portable.


Vision i.f. response curve 'Olympic II'. Note sound rejection notch.

the usual response curve published for this is the voltage curve, as a glance at the corresponding photograph will show.

This wobbulator contains no provision for internal frequency markers, and thus the curves displayed are pictorial only. However, if the output from a calibrated signal generator is fed into the i.f. amplifier under test along with the wobbulator signal, and the amplitude adjusted appropriately, a frequency marker will be seen when the signal generator is tuned within the frequency response band of the i.f. amplifier. This will appear as a "blip" which can be made to traverse the response curve at will by tuning the signal generator. Thus all the important features of a response curve can be examined; bandwidth between the "3dB down" points, rejection notch frequencies, "overshoots" or ringing, tilts or skewness due to Miller effect, spurious responses in the amplifier, discriminator linearity and bandwidth in the case of f.m. receivers, and so on.

With the "fixed" oscillator set at 150Mc/s central frequency and "wobbulated" ±10Mc/s the output at the extremities of the sweep is in the prototype within 1dB of the output at 150Mc/s. With a ±5Mc/s sweep the output is within 0·2dB of the nominal. Thus no spurious tilts or peaks in the displayed curve will be noticeable and the instrument is capable of supporting measurements at least to the accuracy usually required in circuit design and development. The variably tuned oscillator output does vary with the tuning capacitor setting, as would be expected; but as this is kept at one frequency while the other is wobbulated and the output is small compared with that of the wobbulated oscillator, this does not matter. However, it does give rise to a particular effect, which may be noted. Since the output signal required may be obtained by any combination of frequencies from the oscillators, so long as their difference is the same, it may readily happen that by choosing different settings for these two oscillators on two different occasions, the output signal amplitudes may well be different. This does not mean the instrument is defective. If, of course, oscillator 1 is used at a fixed central frequency, by using a fixed d.c. bias on the SVC1, the effect will not be in evidence.

One final word: in spite of what was said earlier about jitter when low frequency i.f.s are being generated, response curves at 465kc/s can in fact be displayed usefully with this instrument. When setting up to generate low frequencies it is preferable to monitor aurally, otherwise the signal may be lost through too rapid tuning of the variable oscillator, and in any case to centralise the displayed curve may be very tricky. It may be desirable therefore to fit the tuning capacitor with an epicyclic or other slow motion drive. These effects become very much less bothersome when the generated i.f. is higher; tuning for 10·7Mc/s is simple, and at 34-38Mc/s it is even quite "broad".

Note: The cover photograph that appeared in the March issue shows the filter elements mounted on a separate printed circuit board. This was done with the prototype for development purposes only, and the complete mixer and filter circuits are in fact on one board only, as shown in Fig. 3. ■

STORAGE TUBES F

ALTHOUGH there is no immediate application for slow-scan television in the domestic television field, it is now a very important branch of television technique, and one which is well advanced. The rate at which a picture may be built up to form a frame depends very much on the bandwidth available. If, for example a picture must be transmitted by low-frequency radio links, or over normal telephone lines, then slow scan methods are essential in order to preserve resolution in the limited bandwidth available. For many years, new methods of coding the television signal have been proposed and tried. Most of these methods involve reducing the signal to digital form by a computer process and reconstructing it at the receiver by similar methods. Digital coding is very expensive in equipment and can be justified only when very great economies in bandwidth are essential; its use is at present restricted to space communication, where the bandwidth must be restricted in order to reduce noise to a minimum.

DIRECT-VIEW STORAGE TUBE

Another method considerably less expensive than the digital technique, employs a long persistence c.r.t. so that the frame rate of a TV transmission can be minimised. This method has been used with considerable success for long distance amateur TV, but it has all the disadvantages which surround the long-persistence tube—low brilliance, short life, and uncontrollable persistence characteristics. Suppose now that a tube was to be invented with a brilliance two hundred times greater than conventional tubes, a logg service life, and persistence adjustable at will from a fraction of a second to several minutes? In fact, such a tube exists and is labelled "Direct-view Storage Tube". Apart from its applications in slow-scan TV, this type of storage tube can hold a stored picture as a "still" for a considerable time. The scan used to store the picture may be fast or slow, and the storage time depends on how long the picture has to be viewed; it can be held dormant for months waiting for inspection. This has applications in radiography; a camera can be used to produce a one-frame signal from an X-ray fluoroscope screen. The X-rays need be on only long enough to produce the single-frame scan, but the picture may be inspected there and then for several minutes. The brilliance of the picture is high, in contrast to the usual fluproscope picture, and is viewable immediately, unlike a photograph.

The use of the storage tube in oscilloscopes brings equally gratifying results. Much advanced research work today involves transient effects, events which happen over a short period of time and are not readily repeatable. An example is the voltage surging in high tension electric supply cables when a contact-breaker operates. Until the storage tube became available, these phenomena could be recorded only by coupling a movie camera to an oscilloscope and trying to stimulate the transient during filming. This was not very successful, as the brilliance of the oscilloscope tube was very low, and there was no way of ensuring that the transient would not happen during the fly-back time of the oscilloscope trace or the pull-down time of the camera film. With a storage-tube oscilloscope, such as the very successful "Remscope" by Dawe Instruments, the transient can trigger a trace on the waiting oscilloscope, and store it for later viewing. This makes it possible for engineers to study transient effects which they cannot stimulate such as the effect of lightning on power lines.

The stogage tube, which has made all these things possible, is a fascinating electronic device. Strictly speaking, camera tubes, such as image orthicons, vidicons and Plumbicons, used in television are forms of storage tube, but we are concerned in this article with the tube which resembles the normal c.r.t., the Direct View Stor-

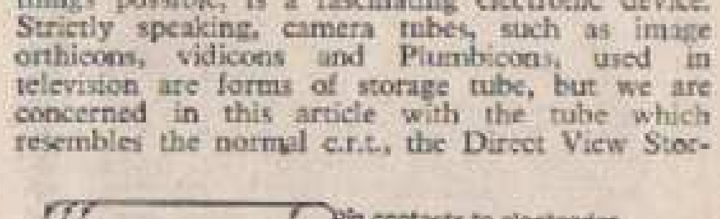


Fig 1: Constructional details of the Direct View Storage Tube.

age Tube (DVST). We shall, however, mention another type of storage tube which makes it possible, among other things, to convert from one TV line system to another, or from a P.P.I. or spiral scan to a TV raster scan.

The DVST works on a principle entirely different from that of the old long-persistence c.r.t. In the latter case, the phosphor screen is a material which continues to glow for some time after the electron beam has hit it. The phosphor of the normal TV tube does this to some extent so that there is not too much difference in brilliance between the start of a frame and the end. Complete fade-out takes a considerable time, and the last frame scanned can often be seen faintly stored on a TV screen in a completely dark room long after switching off the set.

The DVST works on an entirely different principle: that of *charge storage* on a dielectric.

FOR TV

by K.T.Wilson

Figure 1 shows the portion of the tube which is responsible for the display of the picture, it is known technically as the "Flood Section". An electron gun of fairly conventional type, but with large apertures to pass high current, faces the screen. Grid 3 is a "Collimating electrode" which may be of metal, or be simply a coating of carbon on the glass wall of the tube. Its purpose is to spread out the beam from the electron gun and cause it to approach the mesh, G4, in the form of a cylindrical beam of almost the same diameter as the tube. Grid 4 the metal mesh, looks like a piece of very fine nylon stocking, yet made of stainless steel. Most of the electron beam, now collimated (made parallel) by G3 will pass through this mesh, also known as the collector mesh, which is held at a potential of several hundred volts. Grid 5, another mesh, is finer still and at a potential of only a volt or so. This is the part of the tube which is responsible for the storage action, and we shall examine its construction in detail later. At the moment, its electrical action is what is important to us.

Electrons passing through the storage mesh, G5, are accelerated to the screen which is at a potential of 7kV or more. Since the electron beam is in the form of a cylinder of nearly the same diameter as the tube, the screen will be uniformly illuminated over its whole face. The potential of the G3 controls the diameter and uniformity this illumination, and usually we have to ma some compromise between having the maximu possible area illuminated and having the greate degree of uniformity of illumination of a small diameter. This action of illuminating the who of the screen without scanning is term "flooding", and the action of the flood section the tube is of the greatest importance. The floo beam must be kept running continuously as lon as the tube is to be viewed.

THE STORAGE MESH

We have said that, when the storage mesh, G is run at a volt or so positive relative to the floo beam cathode, practically all of the beam pass through the mesh and is accelerated to the scree causing the uniform illumination. If the volta on the storage mesh is now slowly lowered, will be found that the screen darkens as the me is taken negative, and is virtually black when th mesh is only a couple of volts or so negativ (depending on the construction of the mesh) the flood-gun cathode. Thus, the mesh is actin exactly like the grid of a conventional valve, an can control the beam of electrons passing throug it. A "mesh cut-off characteristic" can be draw for the tube-screen brightness being plotted again storage-mesh voltage to give the graph in Fig. This characteristic has a very sharp cut-off, very small voltage swing on the storage mes will make a very large difference to the scree brightness; we might say that the triode forme by the flood-gun, the storage mesh and the scree had a very high Gm. If we could now *selectivel* vary the voltage on storage mesh, we coul expect a corresponding pattern of light and shad on the face of the tube; in other words, a pictur would been seen. The method of obtaining different voltages on different parts of the storage mes is the most vital step in the operation of th tube, and the most difficult to understand.

STORING THE PATTERN

Imagine that, instead of a mesh in the place o the storage mesh, we had a huge array of tin capacitors, one plate of each shaped as a tin grid for the electron beam, the other plate of eac connected to a common point (see Fig. 3). If eac of these tiny capacitors should now be charged u by means of a voltage applied between the commo point and a wire which touches each of the grid-shaped plates in turn, and if the voltage on th wire is varying so that each capacitor is charged u to a different voltage, there will then exist a pattern of voltage on the grid-shaped plates of thes capacitors which will have the effect we desire We shall have a grid network with different point at different voltages, so that an electron bea approaching the network will pass through or b repelled according to the voltage on a particula

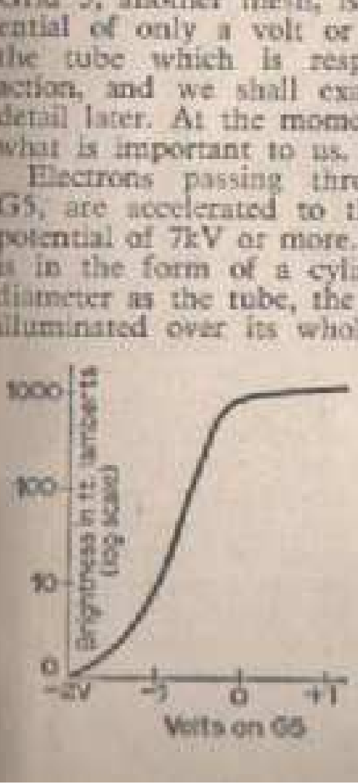
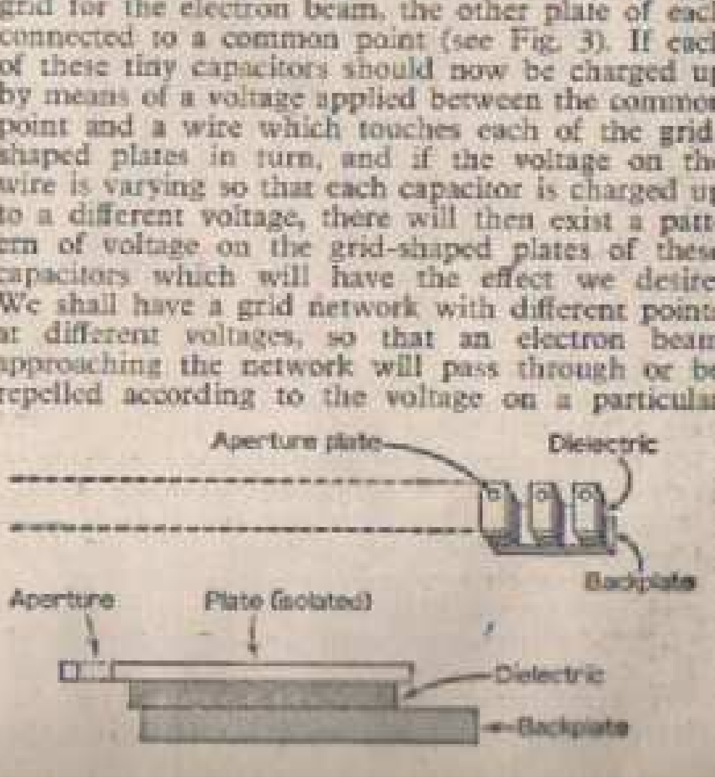


Fig. 2 (left): Tube screen brightness plotted against storage-mesh voltage.

Fig. 3 (right): One of the "tiny" capacitors formed by the storage mesh.



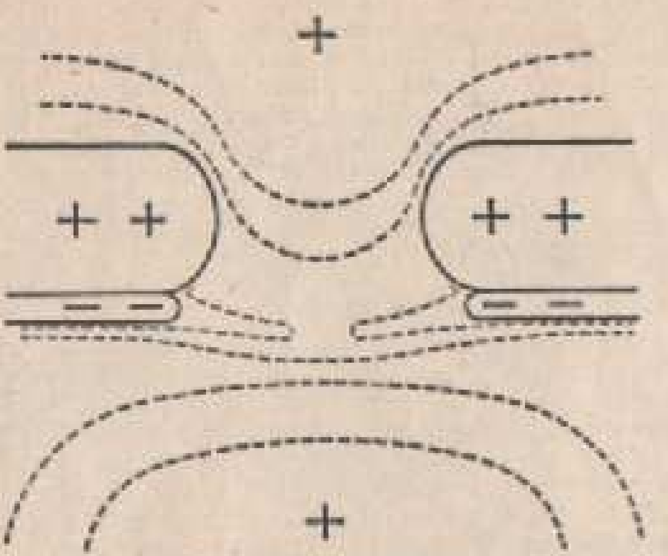


Fig. 4: "Coplanar grid effect"

capacitor. If the electrons passing through the network now hit a screen, we will have a pattern of light and shade on the screen corresponding to the pattern of voltages on the network of capacitors.

The problem now is to make such a network of capacitors. If we take our storage mesh, and deposit on it a thin layer of an insulator, we can use the mesh itself as one plate of a network of capacitors. The other plate need not exist, because the charge of a capacitor resides in the insulator, or dielectric, as it is known. The reason we must have two plates on the capacitors we use in normal radio work is that we have no way of charging and discharging the capacitor otherwise, but, as we shall see, we have other methods in the storage tube.

We now have our network of capacitors formed by depositing a thin layer of insulator on the mesh. Thin means about a ten-thousandth of an inch in this case. Assuming that we can in some way vary the charge on these "capacitors" to form a pattern, we have now the method of controlling the formation of a picture. If the electrical leakage along the insulator is very small, and it can be made so, because the whole assembly is in a vacuum, then the charge on the "capacitors" will last for a very long time unless there is some means of discharging them. This is the storage part of the operation of the storage tube. Note that the charge on the capacitors can still control the electron beam approaching the mesh, even though the voltage on the mesh is positive; this control is known as "coplanar grid effect" and its operation is shown in Fig. 4.

CHARGING AND DISCHARGING THE INSULATOR

We cannot charge and discharge the capacitors by means of wires, since we are operating inside an evacuated tube. However, we can use electron beams; the movement of electrons in a beam is as much of an electric current as movement of the electrons in a wire. Before we can begin to understand this process we must know something of secondary emission. When a beam of electrons strikes a substance, some electrons stay on the surface, some bounce off, and some split up the atoms of which the substance is made to form more electrons. These last electrons are known as secondary electrons, the beam electrons as primary electrons and the bouncing electrons as reflected primaries. Exactly what happens depends on the voltage of the substance relative to the cathode. If the voltage is very low, most electrons bounce or land. Above a certain voltage, known as the *first crossover*, there are more secondary electrons leaving the substance than there are primary electrons landing, and the current reverses. This is the effect encountered in the old screen-grid valves, the reversing current caused negative resistance and hence oscillation.

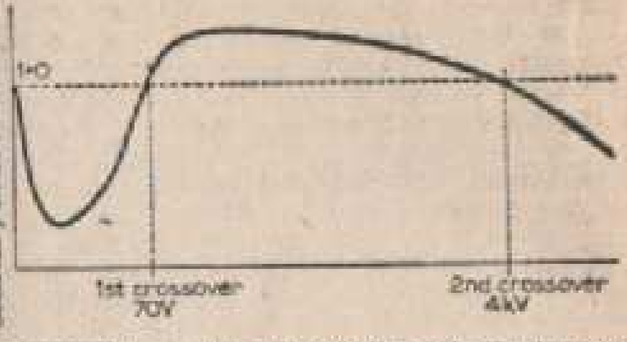


Fig. 5: Secondary emission ratio at the first and second crossover points

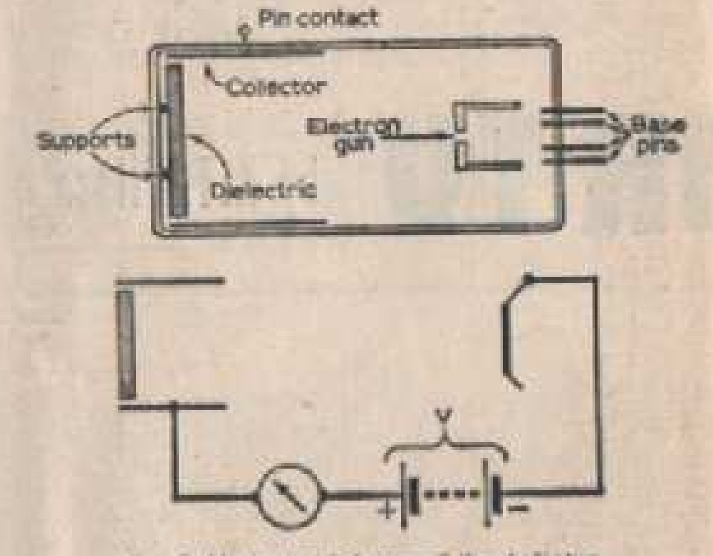


Fig. 6: Method of "charging" the dielectric

The ratio of secondary to primary electrons, known as the *secondary emission ratio*, rises to a maximum, falls slowly as the volts between substance and cathode are increased, and becomes one again at a very much higher voltage called the "second crossover". Note that a secondary emission ratio of one means that as many electrons are leaving the substance as are bombarding it. The graph of secondary emission ratio against voltage is shown in Fig. 5. Usually the first crossover is in the region of 10-60 volts, and the second at 3-6kV. Secondary emission maximum ratio ranges from 1, 2 for most substances to 10 and over for certain photosensitive compounds.

Up to now we have assumed that the substance being bombarded by the electron beam and emitting secondary electrons has been a metal, to which we could attach a lead and measure currents and voltages. Things become rather more complicated if the secondary emitting substance is an insulator, because the voltage of an insulator cannot be controlled from outside, and will vary due to the charging effect of the electrons. Fortunately, it is possible to reason logically what the effects will be and to construct experiments to prove the soundness or otherwise of the logic.

CHARGING OF A DIELECTRIC BY A BEAM

Imagine a piece of dielectric (insulating) material in an electron tube, with an electron gun facing it, and an electrode, the collector, at the side (see Fig. 6). We can vary the voltage between the collector and the cathode and we can measure the current in the collector lead. The collector must be present because we cannot apply voltage or measure current in an insulator. Start off with the collector a few volts positive to the cathode, so that there is an attracting field at the gun due to the volts on the collector. A beam of electrons will be emitted from the gun and will strike the insulator. Now, each electron is negatively charged. An electron landing will therefore carry its charge with it and cause a negative charge to appear on the dielectric, from which it cannot be removed by conduction. After a large number of electrons have landed, the dielectric acquires sufficient negative charge to repel further electrons. The charging curve of the dielectric is shown in Fig. 7. The final potential of a dielectric bombarded by electrons, when the potential difference between the collector and the cathode is below the first crossover is therefore slightly negative to cathode. When the electrons stop flowing to the dielectric (they do not, of course, stop flowing altogether); the collector is at a positive voltage, and the electron stream is diverted there.

Above the first crossover, things are quite different. Usuing the same equipment as in Fig. 6, we imagine the collector now at a voltage, relative to cathode, greater than that of the first crossover. We shall also imagine that the secondary emission ratio is 2, which means that for every electron landing, two leave the surface. If an electron landing charges the dielectric negatively, electrons leaving must charge it positively; and if there are more electrons leaving than there are landing the voltage on the surface of the dielectric must be increasing positively. There must be some limit to this process, and this is set by the voltage on the collector. If the collector were not there, any electrons would be forced to return to the dielectric. When the collector is at a voltage exceeding the first crossover, it will collect all the secondary electrons emitted from the dielectric so long as the dielectric voltage is less than the voltage on the collector. Whenever the voltage on the dielectric becomes greater than that on the collector, all the electrons must return to the dielectric, as it is now the most positive point in the system. Under these conditions, then, the potential of the dielectric must be that of the collector electrode.

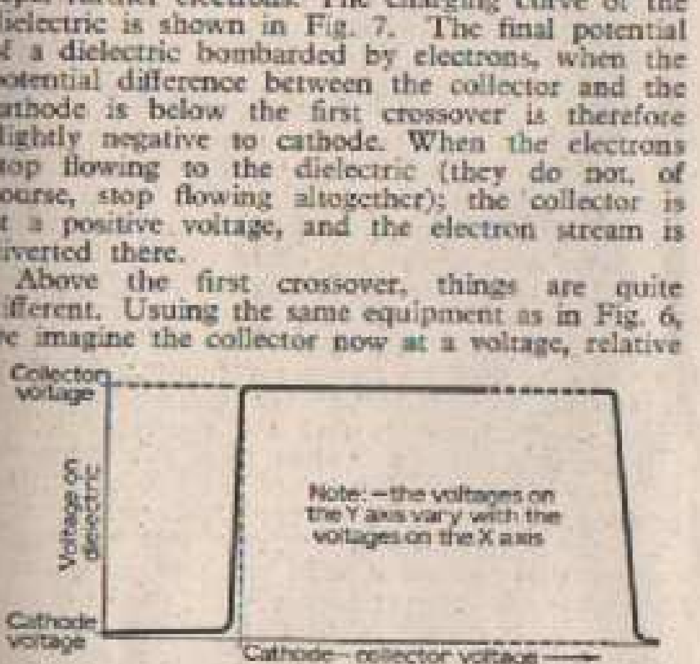


Fig. 7: The charging curve of the dielectric.

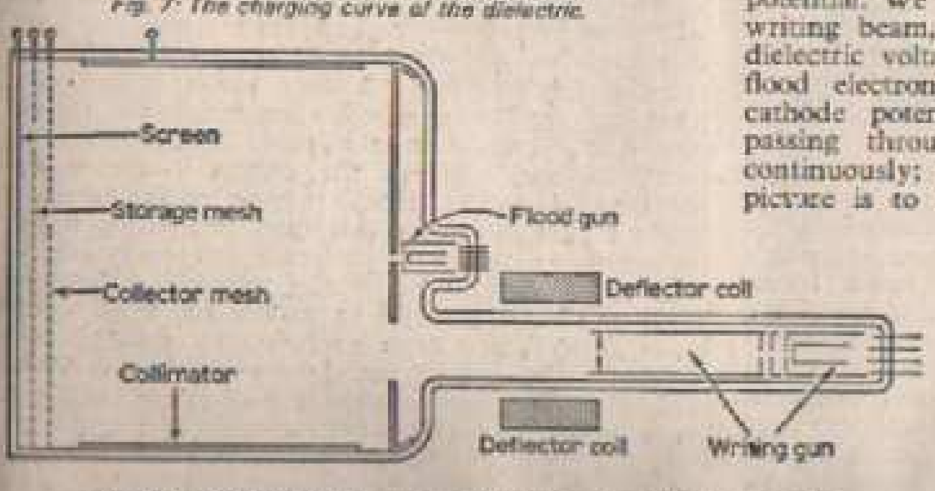


Fig. 8: A complete storage tube—the "writing" gun has been added.

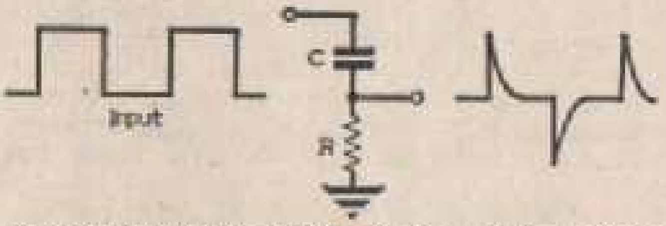


Fig. 9: Using the "tiny" capacitors, C, one can deliberately erase a stored picture so that the tube may be used again.

WRITING A PICTURE

Figure 8 shows a complete storage tube. The flood section is as before, and another section, known as the "writing gun" has been added. This is a conventional electron gun, focused and deflected magnetically or electrostatically. The voltage between the cathode of the writing gun and the collector mesh is several kilovolts, sufficient to set the operating point between the crossovers. The action of the writing beam is to charge the dielectric positive towards the potential of the collector. Towards, but not right up to this potential, for the flood beam is also being aimed at the dielectric, and if the dielectric becomes positive to the flood beam cathode the flood beam electrons land to keep the dielectric at cathode potential. We must therefore avoid overdriving the writing beam, and aim at a condition where the dielectric voltage varies between cut-off, when no flood electrons are passing through, and flood-cathode potential, when all the flood beam is passing through. The flood beam is working continuously; the writing beam only when a picture is to be stored. The writing beam scans the dielectric, which starts at cut-off potential, and charges it to voltages between cut-off and flood-cathode (this might be between −2V and 0V) according to the grid modulation (video, or 'scope signal, etc.) on the writing gun. The writing gun is switched off, and the pattern remains visible through the effect of the dielectric voltages on the flood-beam. If nothing happened to wipe off the charge on the dielectric, we could view the picture on the screen indefinitely; we must have some means of erasing, however, to make the tube useful, and, as it happens, there is a means by which the charge on the dielectric fades away naturally.

ERASURE AND STORAGE TIME

The means by which a picture can be deliberately erased is one of the most ingenious features of the tube. Figure 9 shows the waveform at the output of a simple C-R circuit when a square waveform voltage is applied at the input, and when the charging time of the capacitor is small compared with the duration of the voltage. This is an electrical analogy of one of the storage elements, where one plate of the capacitor is the storage mesh, and the resistor and the other plate of the capacitor are formed by the electron beam. Imagine the storage tube operating, a voltage in the form of the square pulse of Fig. 9 is applied to the storage mesh. The voltage on the beam side of the dielectric must rise by the same amount momentarily, but is then discharged by the flood beam to reach the potential of the flood beam cathode. When the voltage swings down again, the potential on the beam side of the dielectric must follow, and this time there is no beam to discharge the dielectric, since the surface is now below cathode potential as far as the flood beam is concerned, and no electrons can land on the dielectric. This action, illustrated in Fig. 10, has brought the dielectric to a uniform potential, which means that any previous information has been erased, and the tube is ready for further writing. It should be noted that the amount by which the potential of the dielectric is below that of the flood-beam cathode is about the amplitude of the erasing square wave. The erasing process is completed in about a tenth of a second.

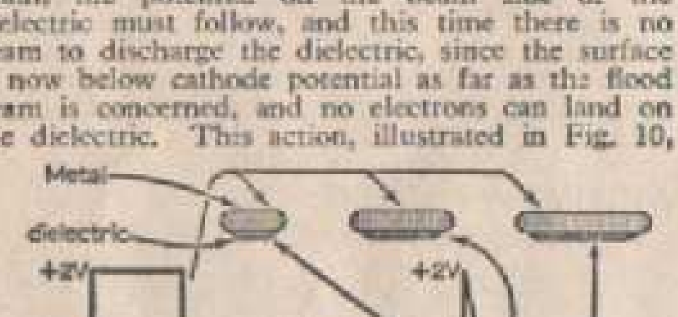


Fig. 10: Applying a square wave form to bring the dielectric to a uniform potential to erase any previous information.

Under perfect conditions, the dielectric would retain its negative potential indefinitely, and the tube could be held at the ready, waiting for a writing operation. The limiting factor is not, as might be thought, leakage in the dielectric, but the landing on the dielectric of positive ions. Every "vacuum" device contains some finite pressure of gas, and the pump pressure of about 10^{-7} of mercury used for storage tubes leaves a large number of molecules per c.c., even if the mean free path of an electron is longer than the tube. Each collision of an electron and a gas molecule leads to ionisation of the gas molecule, and the ions are positive ions and will therefore travel to the most negative point available. In the case of the flood section of the storage tube, this is the negatively charged dielectric, and each ion landing charges the dielectric positively again. Hence, if the tube is erased as described, and left, the screen, blank after erasing, will gradually brighten up as the potential of the dielectric increases towards the flood cathode potential. The same will happen to a stored trace; loss of a stored trace is not by dimming of the trace but by brightening of the surrounding parts of the picture, the net result being the same, a loss of contrast. There are several methods of diminishing this effect. Firstly, the vacuum in the tube may be improved, and this is best done by continuous use, since the ions landing on the dielectric are removed from the gas phase. The time for which a "black picture" may be stored on a newly-pumped tube is short, thirty seconds or so. On a tube which has completed ageing before being sent to a customer it has probably improved to 2-5 minutes, on a tube which has been in use for five hundred hours it will be of the order of ten minutes or more. The second method is to cut off the flood beam. In this state the picture cannot be viewed, but it is stored, and the storage time appears to be very long, six months at least. Occasional viewing is permissible, and the storage time is then set by the total time for which the picture has been viewed. If desired, all supplies to the tube can be switched off, and the tube put on the shelf, still storing a picture which can be viewed again by plugging in the tube and switching on. The third method is to pulse the storage mesh with small amplitude, short duration voltage pulses. We have already said that the application of a positive voltage to the storage mesh causes electron landing. If the pulses are arranged so that the electron landing is approximately at the same rate as the ion landing, a considerable degree of compensation is achieved, and viewing times may be extended up to several hours.

A train of voltage pulses on the storage mesh can also be used to obtain a variable persistence. If the voltage or duration or frequency of the pulses is increased beyond the values at which compensation for ion landing takes place, erasing will take place, and the rate of the erasing will be proportional to these three variables. In this way, the persistence of the tube can be closely controlled to any of a wide range of values, and the form of the persistence, the shape of the graph of brilliance against time can also be determined to some extent by choice of the shape of the voltage pulses applied. Compared with the old long-persistence cathode ray tube, the storage tube has a formidable number of advantages. The screen brilliance is very much higher, and this high brilliance is not obtained by increasing the e.h.t. applied to the tube. Since the flood beam is not scanned, the screen is continually bombarded by electrons in the parts where a trace is showing; this continual bombardment, as opposed to the very intermittent operation of the conventional tube, is the reason for the high brilliance, high enough to enable the trace to be seen in daylight, even sunlight. By contrast, the long-persistence c.r.t. could be viewed in darkness only. The continuous operation of the flood beam is responsible for another advantage, longer life

—continued on page 367

Servicing TELEVISION Receivers

No. 134 - MURPHY V470, V480, V490, V500 and associated models - *continued*

by L. Lawry-Johns

No signals

With no sound or vision, check V1 (30L15) and V2 (30C1). If necessary check V3 (6F23). Also it is worthwhile checking the voltages to all three valves. This assumes a raster is present and is controllable, and also that the aerial is effective. If the 30C1 and the 30L15 have been accidentally transposed, check R502 (100Ω) bias resistor of the 30L15, and the h.t. feed resistors if necessary.

No picture, no raster

The first thing one should do is check if the line whistle is there. If it is check visually if the e.h.t. diode (U26) lights up, and if it is possible check the diode for e.h.t. If there is no e.h.t. on the diode, check the 30P4 and the U191. Check C82 if necessary. If the line whistle is weak, or absent until the top cap of the U191 is removed—when the e.h.t. partially returns—it is pretty certain that C82 (0·25μF) is shorted. In some cases, some sort of picture may be resolved when the top cap of the U191 is removed. Capacitor 82 will be the culprit anyway. The normal boost line voltage is 625 volts. This figure does not indicate any other line standard!

No picture

If the sound is in order and the raster is controllable, but on the bright side, check the decoupling capacitor 21 (0·001μF) hooked to pin 8 of V4 (6F23) by bridging it with a known good capacitor. Increase C19 to 1,800pF if necessary. Should the raster be darker than normal, check V6 (30FL1) and its associated components. With a brighter than normal raster, but one that has dark bands, check V5 (6D2) for a heater-cathode short. If the picture is present, but is shaded by the raster, check V6 (30FL1) similarly.

Line hold

If the line hold control is at the end of its travel, check V12 (6/30L2) and R114 (680kΩ). Alter R113 to 68kΩ and R117 to 4·7kΩ if V12 and R114 are in order.

Lack of height

With an even loss at the top and the bottom of the picture, check R88 (180kΩ). For bottom compression, check V11 (30P12) and C71 (100μF). Bottom compression with fold-up, check V11, C68 (0·05μF) and C72 (0·1μF)—the capacitors for leakage. It is wise to check the settings of R96 and R107 in any case.

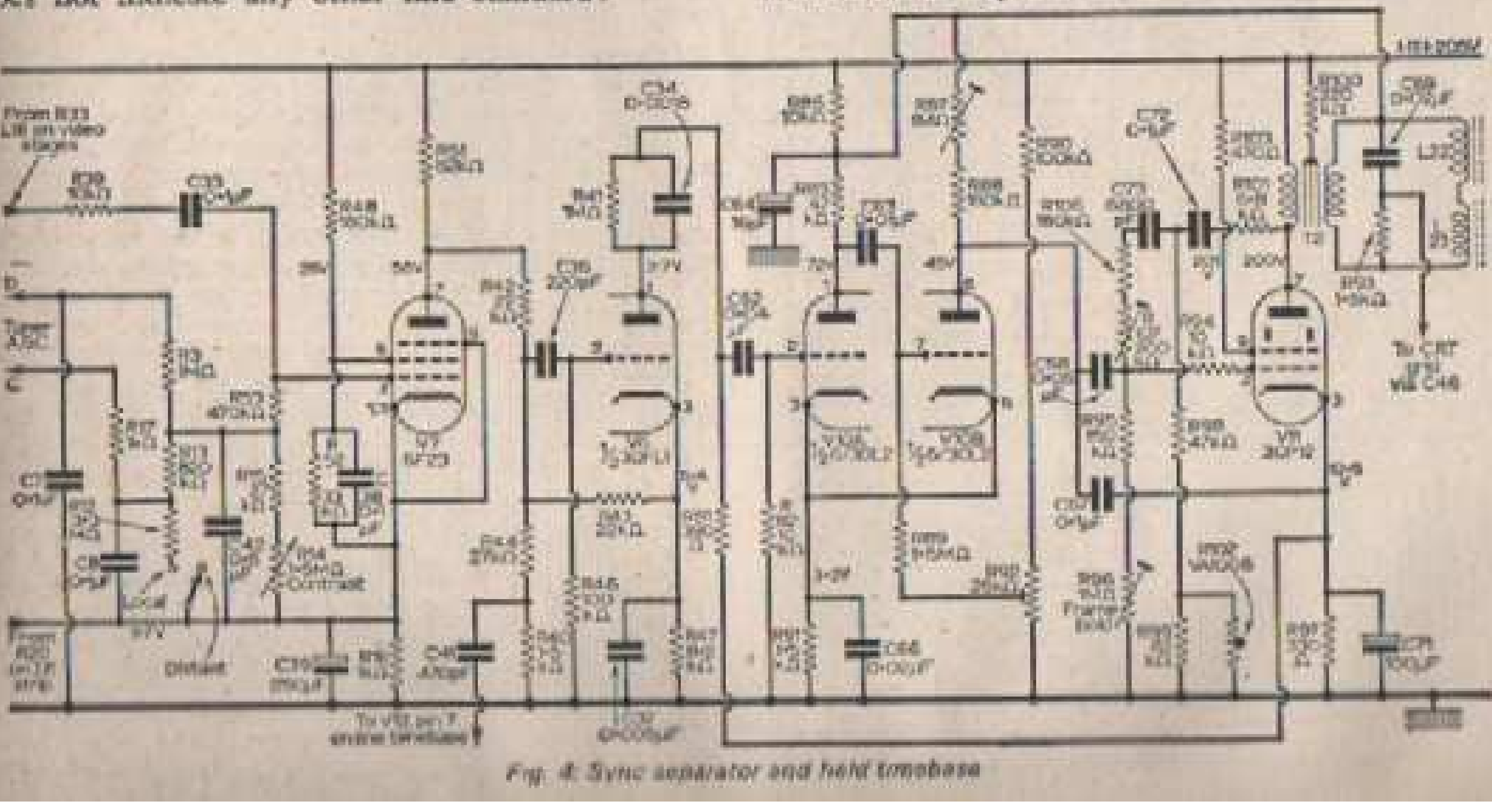


Fig. 4: Sync separator and field timebase

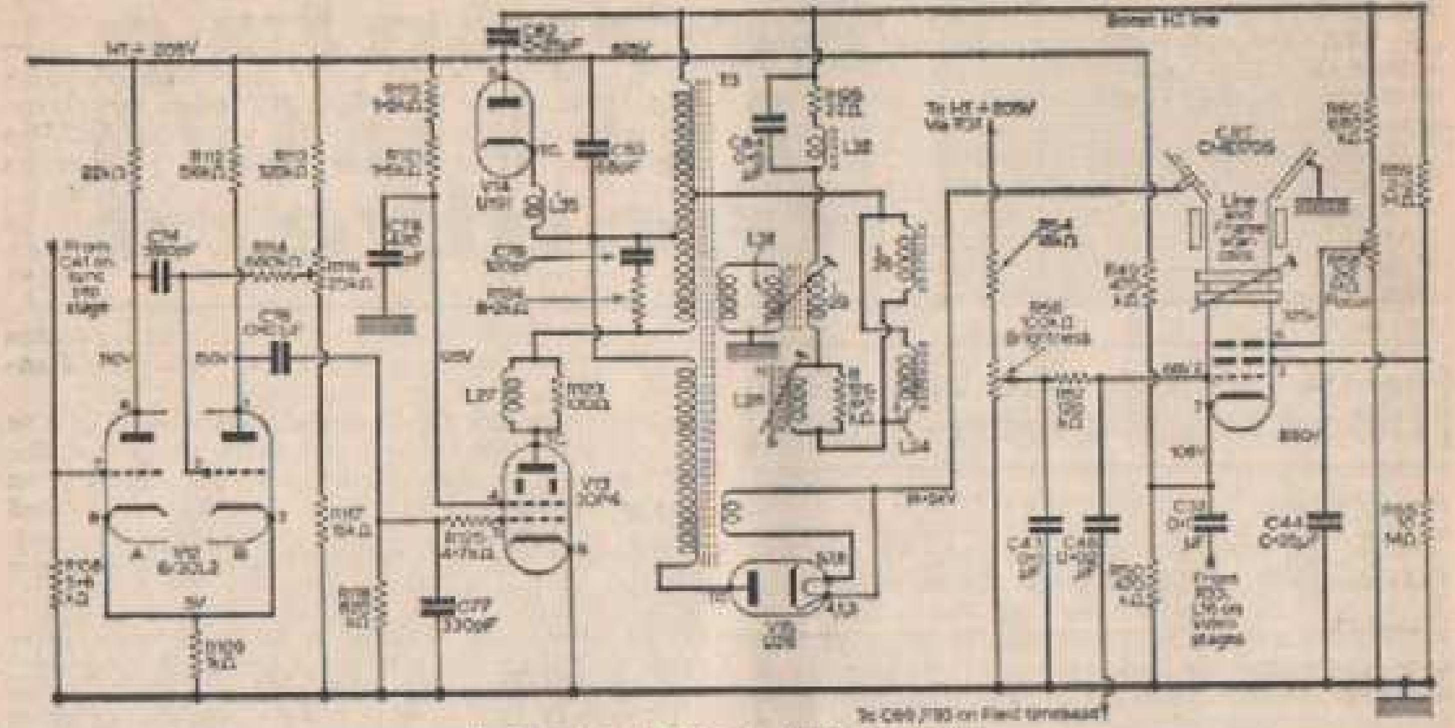


Fig. 5: Line oscillator, output and c.r.t. circuitry.

Lack of width

A good first test is to check the h.t. voltage. It should be 200V or thereabouts. If it is not, replace the rectifier if necessary—type HT10 or a silicon diode of suitable rating. If the h.t. is normal, check the 30P4 and the screen grid resistors R119 and R121 (both 1·5kΩ).

Another problem is that the 30P4 overheats. When it does, check the resistors R119 and R121, C76 (0·01µF) and V12 (6/30L2).

Sound troubles

Absent sound with a normal picture leads you to check V9 and its associated voltage supplies. If a good hum is available when pin 2 is touched, check V8 (6F23) and its supplies, etc. Should the sound seem harsh, change R76 to 150kΩ and wire a 330pF from the grid (pin 8) to chassis. For distorted sound, check R73, C58 and V9.

Field hold

Check V10 (6/30L2) and R89 (1·5MΩ) if the field hold control is at the end of its travel. If the hold is weak, check V6 and associated components, particularly those to pins 1, 2, 3 and 9.

No sound or vision

If the valves continue to light up, but there are no other signs of life, check F2 (500mA) the h.t. fuse. Also check the a.c. path along R127, 128 and 129 dropper sections. If the valves do not light up, check dropper sections R131, 132, 133, 134, 136 and 137. Then check the heater chain through to the c.r.t. If there are no signs of life on the dropper, check the mains fuse F1 (2A).

Adjustments

Apart from the usual adjustments, it is as well to know that to centre the picture one must rotate the ring magnets behind the deflection coils on the neck of the tube. Tilt is achieved by releasing the hexagon screws and inserting a long P.K. screwdriver into one of the holes on the left-hand side of the tilt ring, and rotating the ring to straighten the picture. Once this has been done it is advisable to tighten the screws. They can be easily overlooked.

Cabinet or chassis removal

Models V470, V470WA and V500: Lay the receiver face down, remove the mains connector and the two screws from the cabinet, and lift off the cabinet. To obtain access to the front of the

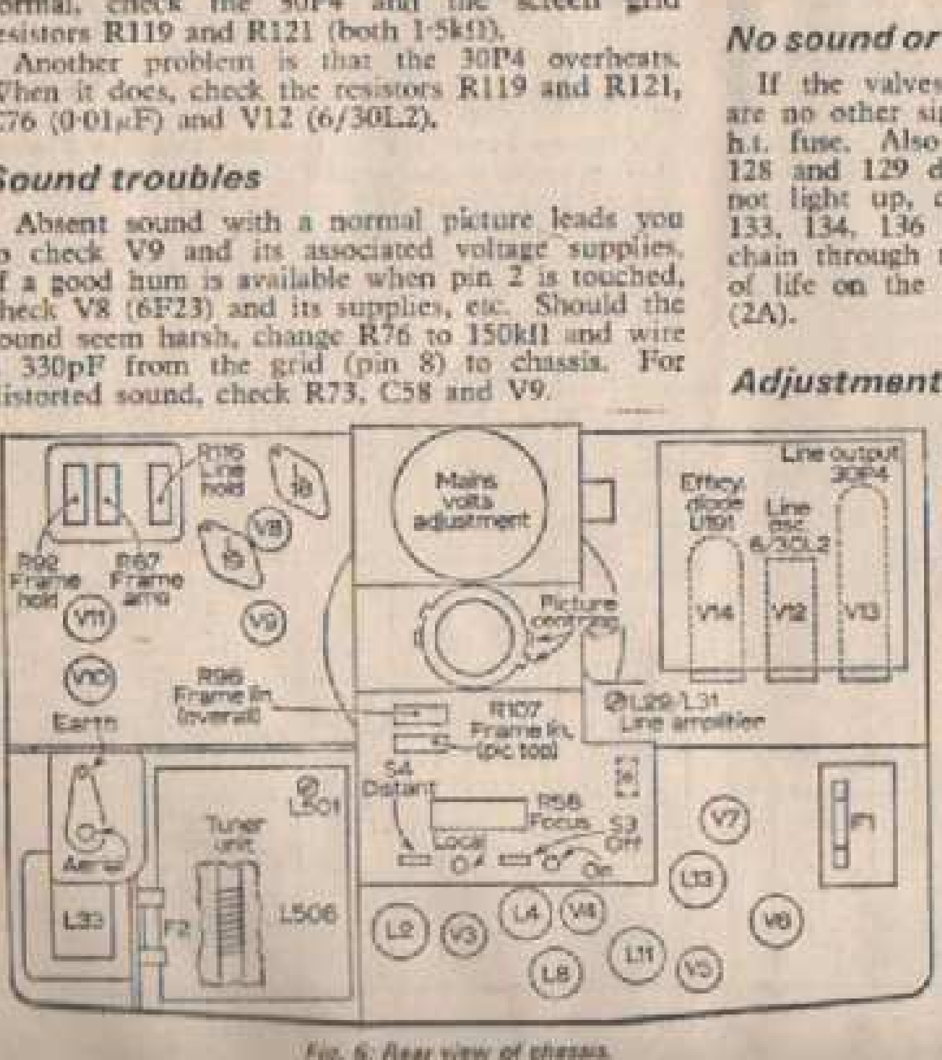


Fig. 6: Rear view of chassis.

chassis, keep the receiver on its face, disconnect the e.h.t. lead and base connector from the tube, remove the four screws fixing the chassis side members to the front support arms and lift chassis clear.

Model V480: Proceed as above, but the chassis is held by two wing nuts at the sides which must be loosened before the chassis can be lifted clear.

Model V490: Remove the trim from the front of the cabinet and stand the receiver face downwards on a soft platform of a smaller area than the safety glass so that the weight is not put upon the outer edges of the cabinet (or mask). Remove the two screws from the back of the cabinet and ease off the cabinet shell. Loosen the two wing nuts to gain access to the front of the chassis.

Tube removal

Model V470, V470WA and V500: Lay the receiver on its face and remove the four screws fixing the moulded frame to the front support arms. Ease the rubber mask away from the tube and lift off the chassis from the mask and frame. Loosen the four shackles at the corners of the clamping ring, slacken the clamping ring screws and withdraw the c.r.t.

Model V480 and V490: Remove the e.h.t. and base connectors from the tube, remove the safety glass, loosen the c.r.t. clamping screws and remove the picture tube—easing it out of the mask from the front. Ease the replacement tube into position and ensure that the front of the tube is half-inch from the safety screen.

When the chassis is in the cabinet, the tube front can be centralised by means of the two mushroom shaped adjustable supports at the bottom of the cabinet. Adjusting screws are located beneath the cabinet just behind the front feet, and they should be turned to raise or lower each side of the tube as required.

STORAGE TUBES

—continued from page 364

of both cathode and phosphor; due, it seems, to continuous as opposed to intermittent operation, and to the phosphor used. The long-persistence tube must use a long-persistence phosphor which is short lived; the storage tube is free to use any phosphor, since the action of storage does not depend on the phosphor.

Comparing the storage tube now with photography, the storage tube can be viewed instantly. If photographs are needed, the simplest device is sufficient, due to the high brilliance. The storage tube can be kept ready, so that an event may trigger the tube into making a trace and unwanted traces can be erased at once.

The ability to control persistence of traces is so completely novel as to fall into a class by itself. Nothing of this sort is possible by any other means short of the vast and costly computer, and it is this feature, plus that of daylight viewing, which has led to the installation of storage tubes in radar monitors at London Airport.

The major disadvantage of the storage tube is its comparatively poor resolution. This is due to the electron beam of the flood gun spreading out as it passes from the storage mesh to the screen, and is a fundamental limitation. In some cases (in oscilloscopes, for example) this is of little consequence, but it makes high definition television impossible on a small screen, and is a serious obstacle to the use of the tube with very high-definition radar. Since the resolution *per inch* of screen is fixed by the tube design, the answer to the problem of having more lines *(total)* is to increase the screen size, which would also satisfy the radar requirements. Unfortunately, the cost of present storage tubes increases roughly with the square of the screen diameter, and this ratio seems fixed while the present rather primitive manufacturing methods are used. There seems no reason, given greater demand, for storage tubes to cost appreciably more than tubes for colour TV to which they bear some striking similarities, both in appearance and in technology.

Summing up, the Direct-View Storage Tube is a device whose usefulness has not been sufficiently appreciated to date. Complex as its operation may be, it is simple compared to any other possible method of extended duration display, and, even at current costs, it is economic. Its primary fault, that of low resolution compared to cathode ray tubes of similar construction, can be overcome, if a fixed number of lines of resolution is desired, by increasing the size of the screen. The increase in cost which this would entail would be negligible if more advanced production methods were used. ■

TOWARDS THE AUTOMATIC

By S. GEORGE

Pt. 2: AUTOMATIC CONTRAST CONTROL SYSTEMS

CONSTRAST control in the early commercial designs was achieved by connecting a variable low-value resistor in the cathode lead of an i.f. amplifier valve, and reverse biasing the suppressor grid so that the full voltage is developed across the low-value cathode resistor and allowing only a fraction of it to reach the control grid. To further increase the range of contrast control an additional local/distance switch was incorporated in some sets. This took the form of a constant impedance attenuator or a pre-determined increase of bias.

Designers soon realised that with widely varying reception conditions and the introduction of commercial television, that some form of automatic contrast control additional to the manual setting was necessary: to compensate for signal fading in reception areas outside the main service area; to give some degree of Band I/III balance; and to prevent overloading and cross-modulation in areas of high signal strength.

After trying many "gated" automatic contrast or gain control systems, they were dropped because of their complexities and replaced by the now very familiar "mean level" system, in which the a.g.c. bias is tapped from the grid of the sync separator valve or produced by a special diode or diodes as in many Bush/Murphy models.

In this brief outline the author endeavours to cover some of the major extensions, variations and refinements that have been introduced in "mean level" systems to improve contrast control and give it as wide a range as possible.

Of course a.g.c. is much more difficult to apply to a television receiver than to a conventional valve radio receiver for four reasons. Firstly, due to the higher signal frequencies involved, valve input capacity and impedance changes are more marked and unless suitable precautions are taken, only small variations in valve amplification can be tolerated without considerable mis-tuning. To offset this input characteristic change with varying bias, it is now almost universal practice to include an unbypassed low value resistor (of between 22-32Ω) in series with the cathode lead to the controlled valve. This introduces a degree of unwanted negative feedback, but is the lesser of two evils, while the slight bias developed across it prevents the valve passing grid current when the contrast control is set to full sensitivity and the a.g.c. rail voltage becomes positive.

Secondly, to maintain a good signal/noise ratio, bias should not be increased to the r.f. amplifier until signal strength necessitates and then only at the lowest level consistent with freedom from cross-modulation. In practice this is accomplished by feeding the r.f. stage from a pre-determined tapping on the a.g.c. rail and often "delayed" by

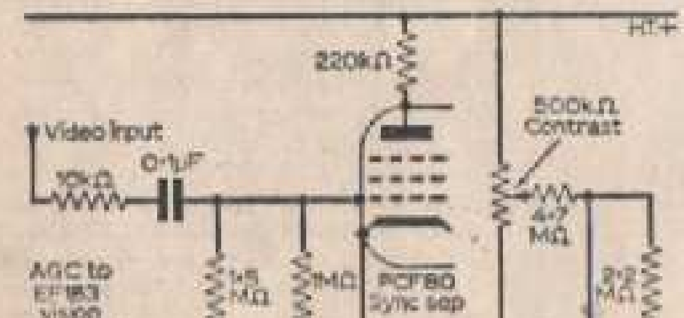
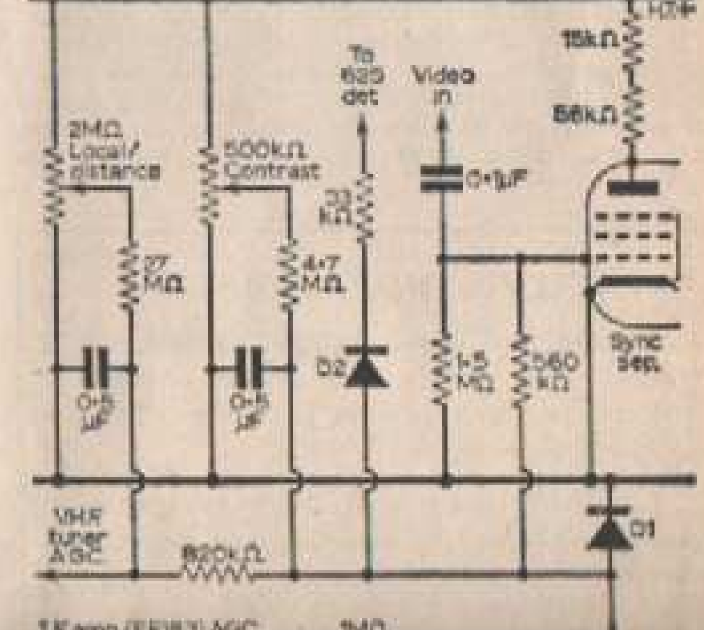


Fig. 1 (above): Typical dual-standard a.g.c. circuit.

Fig. 2 (right): Automatic contrast control system used in the latest range of Thorn portables.



a miniature diode or by utilising the G3 suppressor grid of the sync separator pentode.

Thirdly, to vary the negative a.g.c. voltage derived from the sync separator or special a.g.c. diodes, it is customary to "back it off" with a small positive voltage tapped from the contrast control. Obviously precautions must be taken to ensure that the a.g.c. rail never runs materially positive due to a circuit defect or when changing channels. This is accomplished by connecting a miniature diode across the a.g.c. rail and chassis so that it conducts and "shorts out" positive voltages. Naturally, it can never be a perfect short-circuit so if the contrast setting is too high, just a discernible positive voltage is developed across this clamp diode, but due to the controlled valves having a slight standing bias it fails to make their grids positive with respect to cathode.

Finally, fading and signal strength variations can occur on the sound and vision frequencies of each individual channel, so that separate sound and vision a.g.c. systems are needed. Sound circuit a.g.c. systems are similar to those used in standard radio receivers; the bias voltage is usually tapped from the a.m. detector. On the 625 (f.m. sound), a.g.c. bias is often removed but may be replaced by altering the working characteristics of the sound i.f. amplifier valve.

A typical example of a modern dual-standard a.g.c. system is shown in Fig. 1. This demonstrates how the a.g.c. voltage is delayed before being applied to the r.f. amplifier; until its value exceeds the positive bias given to the D1 diode by the contrast control setting whereupon it ceases conducting and has no effect on the negative voltage. The negative voltage derived from the grid of the PL36 line output pentode has more effect on the main than on the delayed a.g.c. rail and ensures that there is an adequate negative voltage to reduce gain as much as desired in areas of high signal strength and also to prevent "lock-out" on very strong signals on 625, or when the picture content is mainly black, which causes a momentary reduction in the "mean level" voltage developed by the sync separator. This short term reduction in bias on 625 transmissions can then further increase receiver gain, intensify the effect and cause the sync separator to "block" with attendant loss of synchronising action. It is for this reason that most dual-standard contrast control circuits, not using the negative voltage from the line output pentode grid, incorporate an "overload diode" connected from the 625 vision detector to the a.g.c. rail and which conducts when the mean level of the rectified signal exceeds the a.g.c. bias voltage and augments it.

On 405 the "overload diode" is cut out, since increasing modulation increases both the brightness level and the a.g.c. voltage developed. However, in many models this diode is replaced by the triode section (grid and anode strapped together) of a dual type of valve.

A circuit of an a.g.c. system incorporating an "overload diode" is shown in Fig. 2; this is taken from the latest Thorn 16-inch series of portables. D2 is the "overload diode" and D1 the clamp diode; the 2MΩ local/distance potentiometer determines the point at which a.g.c. feed to the v.h.f. tuner becomes operative. The greater the positive potential the larger the delay, but its setting is dependent on the strength of the aerial signal.

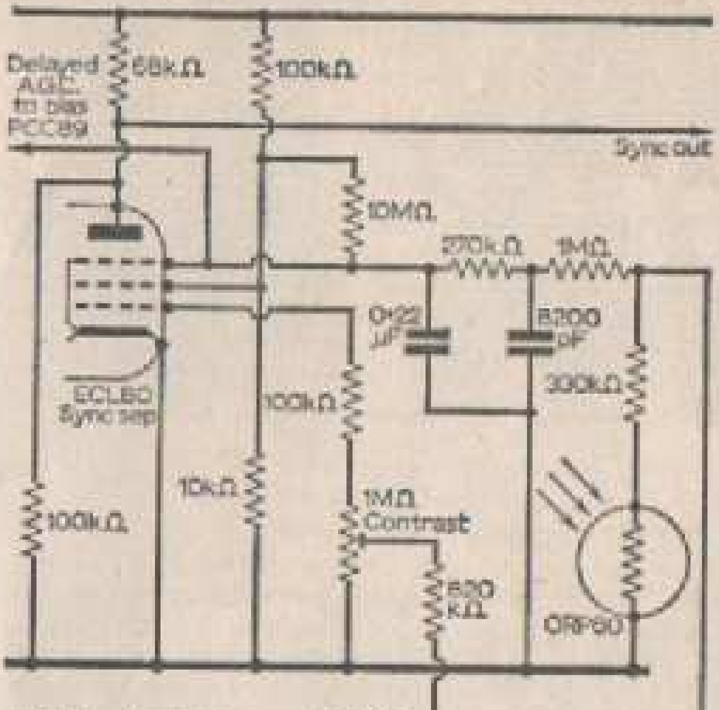


Fig. 3: Fully automatic contrast control system used in many Philips receivers. Note the use of a light sensitive cell.

Light Sensitive Cells

A few manufacturers use light-sensitive cells in the contrast control circuits to automatically compensate for variations in ambient lighting. A characteristic of these devices is that their resistance decreases with light level. They are usually connected to the contrast control so that when room lighting increases the effective voltage taken from a potentiometer increases to further offset the negative a.g.c. voltage. An application of such a light-sensitive cell, as used in many Philips receivers, is shown in Fig. 3. Note that the contrast control is not shunted across the h.t. rail and chassis (to supply a variable positive voltage to "back off" the negative a.g.c. bias), but in conjunction with a series fixed resistor (0.1MΩ) functions as the grid leak of the ECL80 pentode sync separator. Thus, the contrast control sets the "mean level" voltage developed by the pentodes grid action.

The light-sensitive cell is paralleled across the slider output of this potentiometer via a series limiting resistor so that when room lighting increases or decreases the internal resistance of the cell changes the level of the a.g.c. voltage. This bias is then fed to the EF85 i.f. amplifier and at a reduced level to the PCC89 r.f. amplifier. Further, by using the G3 suppressor grid of the sync separator as a diode, the r.f. amplifier feed is delayed until bias reaches a preset level and thus ensures that any valve-generated noise is swamped by the signal.

In the past these light-sensitive cells have also been used to vary the pre-set brilliance level of the c.r.t. with changes in room lighting but have tended to fall out of favour with dual-standard designs.

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DX-TV

A MONTHLY FEATURE
FOR DX ENTHUSIASTS

by Charles Rafarel

CONDITIONS

BY now there should have been a marked improvement in conditions, but neither Sporadic E or Tropospheric propagation has as yet shown any significant improvement. In fact, Sporadic E activity has shown a further decline in comparison with last month and the Tropospherics are still far from satisfactory, largely due to the high winds that have been prevalent throughout the greater part of that period.

All I can say is that, by all laws of average, things just must get better soon! But just to add a little more to the general atmosphere of gloom, I feel that I must add some prediction on SPE activity to be expected in the coming season.

Looking back over the past three years, it would seem that there has been a progressive decline in the duration and strength of the Spring/Summer openings. Last year the season began late and finished early and if the widely held theory that SPE activity tends to diminish as sun-spot maximum approaches, this year may perhaps hardly be a "bumper" one.

There are, however, two happier prospects. The "Trops" should not be affected and possible F2 layer signals should more than compensate us for a reduction in the medium distance SPE/DX. Throughout the month there have been the usual short bursts of SPE activity, but nothing of note, and there was a burst of Tropospheric activity on the 4th and 5th March.

NEWS

(1). Some information supplied by Corporal D Maden of Cyprus that will further help in the identification of the Czech transmitters operating on channel R2: There are two Czech TV services, one in the Czech language, and the other in Slovak. On R2 the Slovak language service is carried by the **Bratislava** transmitter only, whilst the Czech service is via the **Ceski Budovice** R2 station (apart from approximately one hour daily when both stations relay the Czech service from Prague). Therefore the two programmes are different, so if we get a programme on R2 that is different from that on the R1 channel, it is Bratislava, but if the programme is the same as on R1, the station is most probably Ceski Budovice, although there is just a chance that it is Bratislava with its one hour per day relay of the Czech language service. A check on whether the services tally for more than one hour would reveal this.

(2) Since Lille-Bouvigny UHF Ch. 21 moved to this channel there has been a noticeable reduction in signal strength until recently, and this has been attributed to possible use of the original aerial on the new frequency. Over the past few weeks we have noted a significant improvement in reception, and this suggests that the aerial arrays have now been modified for Ch. 21. We would welcome comments.

PROPAGATION

F2 layer propagation predictions for 1967 onwards.

The sun-spot maximum numbers for the period 1956-1960 were from 100-120 at the beginning and end with a maximum of approximately 200 at the peak in 1958-1959.

The predicted maximum for the coming season is not nearly as high as this (only 80-100!) but predictions are not firm figures, and on the 11-year cycle basis, insufficient time has elapsed since the beginnings of v.h.f. radio to be able to give a precise overall picture. So let us hope that the back-room boys have been a little too modest in their predictions. In any case, the increase in the number of high power transmitters should improve our chances.

We should, of course, already be finding some evidence of "the shape of things to come", and in this context I would mention the earlier readers' reports of reception of Nigeria and (?) Rhodesia, and I would draw your attention to the two further readers' reports noted below. It may well be that we are already entering the new F2 season.

READERS' REPORTS

(1) A. Papaeftychiou of Cyprus first reported reception on Ch. E4 of weak English sound (BBC Sports Commentary) with weak indecipherable pictures on 3/2/67, this was followed by a talk in an unknown language.

Further reception on 4/2/67 was better, and the station definitely appears to be of Nigerian origin, possibly Aba or Jai (Radio Kaduna TV), both on E4 in Eastern Nigeria, or from Ibadan E4 in Western Nigeria. A very fine effort indeed!

DATA PANEL 21

U.S.A.

Test Card:

In line with the notes last month, here is one of the more exotic Test Cards for reference purposes, if and when F2 propagation opens for transatlantic reception. It shows one of the American "bulls-eye" cards widely used in the U.S.A.

Channels:

American "A" channels, 525 lines 60 fields/second. Negative mod. Ch. A2 — vision 52: 25 Mc/s. Ch. A3 — vision 61; 25Mc/s.

Also received was Italy Ch. IA on 4/3/67, a good opening of more than three hours, when his children enjoyed the R.A.I. Children's Hour.

(2) R. Bunney reports reception on 5/3/67 of a distorted but audible sound signal L.F. of Ch. B1, i.e. 40Mc/s approximately at 18.50 GMT with the announcement: "This is station KI 1508 Orlando Florida".

This appears to be a commercial point-to-point telephone circuit, but what is really interesting is the transatlantic reception on 40Mc/s, a portent, we hope, of transatlantic TV before long.

(3) D. Boniface of Ripon found that things were not too bad for him after all in January and February. He logged Italy IA, Spain E3 and E4, Portugal E3, Switzerland E2 via SPE, and the Trops opened as well and he got as far as Brocken, East Germany, on E6, for a new country. He also had a mystery, UHF Holland on Ch. 40, and we are looking into this one for him.

TOWARDS THE AUTOMATIC

—continued from page 369

Faults in automatic contrast control systems can usually be placed in one of two categories; spasmodic variations in gain or uncontrollable contrast at maximum or minimum levels. The former is probably the most difficult to locate, and once it has been established that it is a.g.c. voltage and not to variations in valve gain, etc., one should first check the very high value resistors that are extensively used in a.g.c. circuits.

To help locate the fault, it often pays to replace the a.g.c. voltage source with a small voltage battery to determine whether the spasmodic variations are caused by variations of the developed voltage or by intermittent or dry-jointed connections in the feed resistors. It cannot be emphasised too much that the receiver section itself must be completely cleared before attention is turned to the a.g.c. lines. Probably the surest way of clarifying the situation is to completely remove the a.g.c. supply (short-circuit the a.g.c. rail to chassis) and work the receiver from a room type aerial to prevent overloading.

Uncontrollable contrast is often due to a break in the track of the contrast potentiometer or to an open circuit feed resistor from the slider to the a.g.c. rail. Care must be taken, however, as receiver defects can simulate contrast control symptoms.

625 LINES IN 405 CHANNELS

—continued from page 354

and 'estimated'; half-bricks are used on the site!

In Fig. 5 the practical half-element point S at (a) scans the same row of mixed elements, 1 to 10, extricating itself between them sufficiently to obtain the required flat-top photo-electric response at (b), which gives clear resolution along the traced lines. Blacks and whites are well defined, and greys at G are clearly distinguished between their neighbours, black or white. The effective scan unit is shown between X—X: its area is 2/3 elemental (element wide, only 2/3 as high) allowing S to move freely and define it.

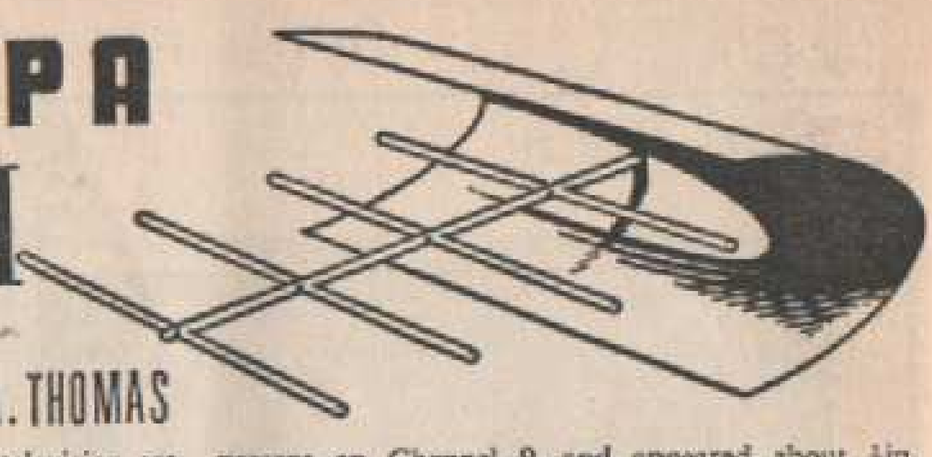
British 625

Despite the unbalanced scanning, our unique 405-line system can be easily improved to transmit 625 lines from our present v.h.f. stations and maintain the economical 3Mc/s video channels. To perfect the scanning the present line frequency of 10,125 would be increased by less than 300, to release the hidden lines for addition to our present total, closing them up. At little cost, the authorities could make small changes at existing transmitters to give superior definition of 625 lines.

While other countries waste bandwidth with their C.C.I.R. standard, Britain could regain the lead in television, as will be explained in the second part of this article.

HOTTING UP A BAND III AERIAL

by A. THOMAS

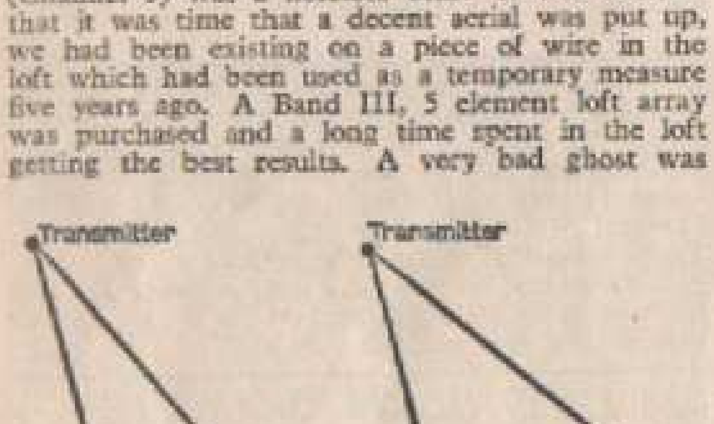


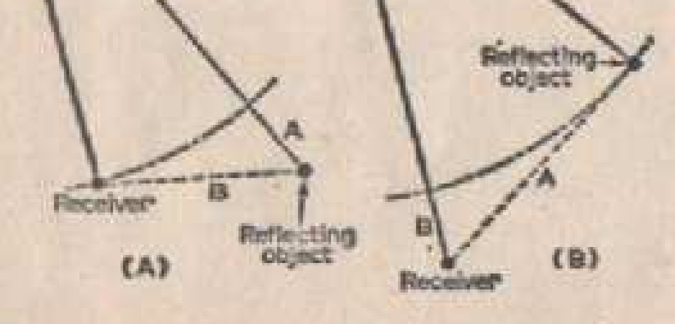
HAVING had my KB SV30FM television set for five years, I decided that it was time an overhaul was carried out. The two PCL82 valves were replaced, they had very low emission on the triode section, the R20 (U26) e.h.t. rectifier had virtually no emission at all, and the PCC89 tuner valve had previously been replaced by a PCC84 to get the set working, this was low too and a PCC89 was substituted. The PL36 line output was also replaced.

These replacements improved the picture brilliance and the lock was very good. The BBC-1 (Channel 1) picture was reasonable, but ITA (Channel 9) was a horrible blur. It was decided that it was time that a decent aerial was put up, we had been existing on a piece of wire in the loft which had been used as a temporary measure five years ago. A Band III, 5 element loft array was purchased and a long time spent in the loft getting the best results. A very bad ghost was present on Channel 9, and appeared about ¼in. after the picture.

Some calculations were performed as follows. With a 19in. screen the horizontal line length is in the order of 15in. With a line frequency of 10·125kc/s, this gives a line time of approximately 5·3μS per inch. If the ghost appears ¼in. after the picture then this represents a time delay of approximately 1·3μS. The speed of propagation of radio waves in free space is 300×10^6 metres per second, therefore with a delay of 1·3μS the distance the delayed wave has travelled must be $1{\cdot}3 \times 10^{-6} \times 300 \times 10^{6} = 390$ metres. This appeared to point to a large oak tree which is just behind and to one side of the house. This distance is not just the distance from the cause of the ghost, but the combined distances of A and B as shown in Fig. 1. From some assumed calculations, it has been determined that the approximate figure of 2/3 of the calculated distance is the probable

(continued on facing page)





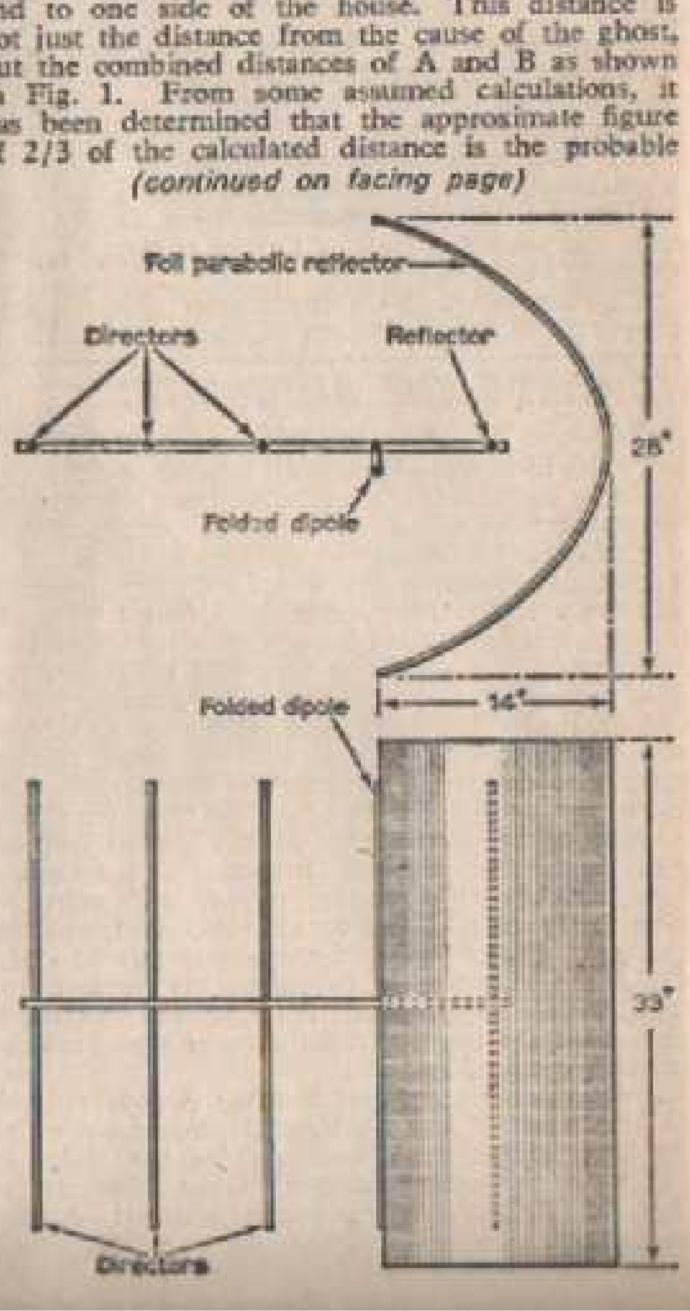


Fig. 1: Plan view and side view of the aerial system with details of the wire frame for supporting the foil reflector. The two figures top left, are referred to in the text and indicate the theoretical position of the reflecting object.

distance from the reflecting object to the receiver.

It is known that wire netting is used for ground plane reflectors and such but it appears to be expensive, especially as it is usually sold in 25yd. rolls. Something was wanted which would increase the directional properties of the array and attenuate any reflection coming in from the side or rear of the aerial.

After some deliberation, the kitchen cooking foil was remembered. This is 18in. wide and about 3ft. of it was hung up from the roof behind the aerial. Some improvement was noticed, but not sufficient to be worth while. A new roll of foil 15ft. x 18in. was purchased and the width was increased by joining two lengths with Sellotape, overlapping the two pieces by 3in., making a total width of 33in. This was fixed initially to the roof with string and drawing pins in a roughly parabolic shape. The aerial was then moved to get the best picture, No ghosts were visible at all.

The distance from the folded dipole to the centre of the parabola is 14in. A framework for the foil may be made from 10s.w.g. galvanised wire, which may be obtained from hardware shops or fencing contractors. Fig. 1 shows drawings of the reflector. The total cost of the parabolic reflector will be in the region of 4s. out of which 7ft. of foil will still be left for kitchen use.

This is not intended as a technical article as the author is not an aerial or propagation expert, but more as a record of what has been done to eradicate ghosts. ■

LETTERS TO THE EDITOR

The Editor does not necessarily agree with any of the opinions expressed by his correspondents

PLEASE PLAY THE GAME

SIR,—I have recently seen letters from readers with requests for back-numbers of PRACTICAL TELEVISION, printed in your Letters to the Editor column. I also have nearly 200 copies including Vol. 1, No. 1. and have written to several enquirers offering copies at a nominal price and postage. I have not received one reply. One would think, seeing that they are getting a free advert., that the least they could do is to acknowledge one's letter, whether or not they accept the offer. I wonder how many other readers have been treated in this way and how many of those requesting help are just looking for something for nothing. After all, we all pay 24s. per annum if only to just flick through the pages.

I should like to add that I find your series "Your Problems Solved" well worth the 24s. alone. Thanking you very much for past assistance with queries.—G. W. DOBB (Llangollen, Denbighshire).

I should like to take this opportunity to ask all readers who do write and ask for information or back numbers to please "play the game". You never know, one day you might offer help to someone and receive absolutely no reply—then it's not so funny is it?—Editor.

PEDANTRY PAYS

SIR,—As most readers may know, the quickest and perhaps the most nefarious method of restoring contrast to a grey picture is to set the mains dropper tapping to a value less than the mains input. In most TV receivers this increases the filament current in each valve (including the c.r.t.) and decreases the resistance in series with the h.t. rectifier. As time passes, however, the number of tappings decreases until . . .

"Is my set ready yet?" *It's not worth repairing.* "Why not?" *All the valves have been overrun.* "How did that happen?" *There is no mains dropper left.* "Have you a replacement in stock?" *Yes.* "Fit another then." *There is no point, there is one in the set.* "You said there wasn't one left." *I meant it had all gone.* "I see, the mains dropper or whatever you call it, is in the set but it has all gone." *That's right.* "There is something wrong with it then?" *No, it's perfectly sound.* "Then why not use it?" *Because it has all gone.* "Tell me, do you get many faults like this?" *No, usually they are much more difficult—I'm doing a soak test on a flywheel sync at the moment.* "I see." *And this morning I had to discharge to earth.* "Hmmm." *Yesterday I had a low-Q tank in a turret.* "I'll tell you what—throw this set away and I'll rent a new one!"—W. M. FRASER (Melton Mowbray, Leicestershire).

HEARD OF A RT14?

SIR,—I bought, in a sale, an R.M. Electric Ltd. 17in. TV, model RT14. Upon removing the back, I found that there were no valves in the set. I wrote to the makers at 21 Seaton Place, London N.W.1. for the valve types and where they should go but had the letter returned marked "gone away". The set chassis is similar to the Masteradio TV receivers. The turret is however different. By fitting valves used in a Masteradio model TG7T I have obtained a raster but no sound or vision. I would deem it a great favour if any readers could supply me with the list of the sequence of valves in this set.—J. MAINWARING (27 Rhiw Road, Colwyn Bay, Denbighshire).

SATISFIED READER

SIR,—I wish to thank you for publishing my letter asking for volumes of *Radio and Television Servicing* (February issue). I was overwhelmed with offers from all over the British Isles and I have now obtained a complete set—volumes 1 to 16.

I have passed addresses to readers who wrote to ask for surplus volumes. It was impossible to reply to all, so thanking everybody who has been so helpful.—S. F. BENT (Droylsden, Nr. Manchester).

IDEAS FOR.....
amateur TV

M. D. BENEDICT.

Part X

THIS article will deal with video distribution amplifiers and an interesting form of video switching known as Special Effects. Although special effects and similar facilities may seem rather advanced for the amateur building his first camera, the author believes that established amateurs, especially those involved in group projects, will find this subject interesting. Beginners who intend to work towards a complete studio system should find this article useful for future reference, especially as the system can be built in simple stages, and developed bit by into the complete unit.

Special effects, sometimes called Inlay, is the method of combining two picture sources on the screen at the same time. The simplest form of Special Effect, and the most often seen in programmes, is the Wipe. A line moves across the screen displaying a picture replacing it with a second picture as it moves. The line can be straight and start at the top, bottom or either side of the screen, or it can move diagonally. It can take the form of a circle or a square usually centred on the middle of the screen and moving out. All these wipes can be simply achieved by switching from one picture to the second, electronically, at an exact point during each line of field, the switching point being controlled by a switching waveform called a Matting waveform, by analogy with the film technique. Fig. 59 shows the basic system.

The methods of obtaining the matting waveform vary with the different types of Special Effect. For the simple wipe this signal is electronically generated, but for inlay proper a camera output is used. This camera views an illuminated background with the shape of the required outline cut out of black paper and placed between the background and the camera; a suitable arrangement being shown in Fig. 60. Thus the output of the camera is a waveform which corresponds to the silhouette; this is amplified and, in effect, clipped to produce a matting waveform which operates the switch cleanly. Any shape or movement can be generated by this means, limited only by the operator's ingenuity. In preparing the silhouette, a camera viewing a brightly lit object against a dark background can be used to generate the matte for its own output. The sharp edge

Fig. 59: Basic inlay schematic diagram.

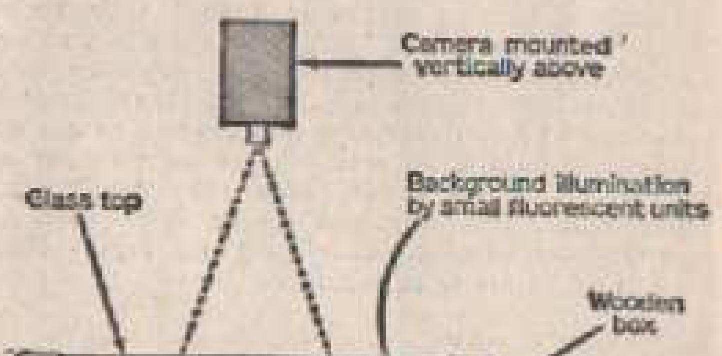


Fig. 60: Inlay desk using a "light box".

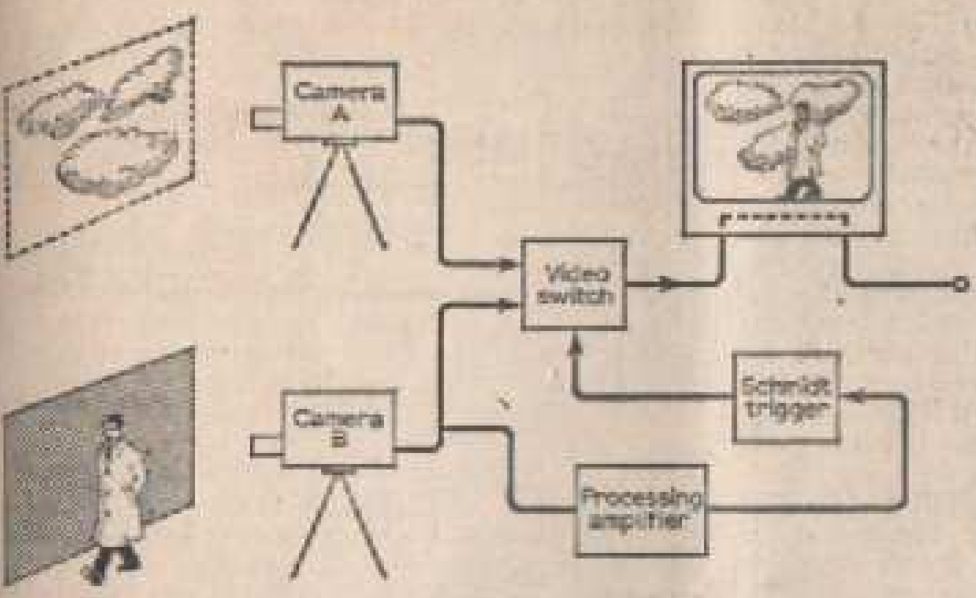


Fig. 61: Schematic of the basic overlay system

between the dark background and the outline of the brightly lit object is amplified and clipped to give the clean edge to operate the video switch. Thus such a matte can be used to switch the outline of a person viewed against a dark background over another background, so that a person can be made to "walk on air", change size, and generally appear in the most improbable or even impossible situations (see Fig. 61). This process is called Overlay.

OVERLAY

Purely electronic generation of the matting waveform is obtained from line or field sawtooth waveforms combined in various manners and phases and then clipped at a particular level to produce the matte waveform. Varying the clipping point will move the position of the change from one source to another (this is shown in Fig. 62). Changing the phase of the sawtooth waveform will alter the direction of wipe. Also shown is the method of obtaining a double wipe to and from the centre of the screen, by using triangular waveforms instead of sawtooth waveforms. Field waveforms are similarly used to give field wipes.

Referring to Fig. 63, the Special Effect has many separate parts, each with an input and an output. The switching waveforms are generated in several separate units, the inputs and outputs of which may be combined to give the required matte. In the case of Inlay or Overlay the camera viewing the silhouette is switched to a stabilising amplifier (as in Fig. 64) with adjustable lift and gain controls to allow the selection of the correct switching point on the camera output waveform. Low level signals caused by blemishes in the tube, shading, dirt on the background, etc., would cause spurious switching but this can be held below the clipping point by suitable adjustment of the lift and gain controls.

Overlay demands very careful setting up of the clipping point so that the complete figure is overlaid without background variations causing spurious switching. The output of the stabilising amplifier is connected to the main Schmidt trigger, which switches at the particular level selected and operates the video switch. The input and output of the various circuits forming Inlay units are brought up on to a 25-way Painton socket, as in Fig. 63. Several plugs fit this socket and are wired up with the different interconnections required, so any combination of units can be connected up simply by plugging in a particular plug. A small diagram of the wipe performed by a particular plug should be inscribed on the cover for reference.

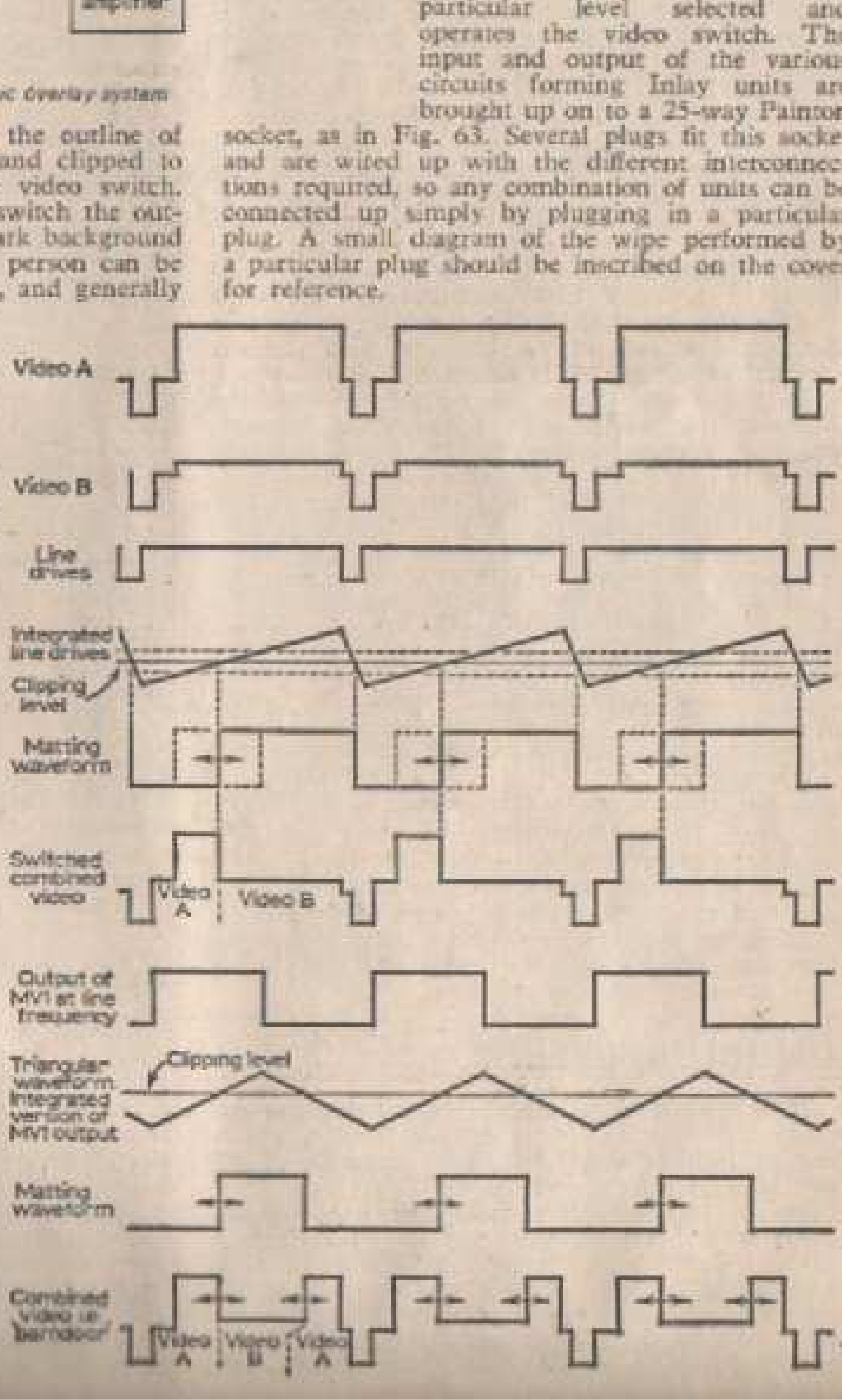


Fig. 62: Waveforms associated with the electronic generation of a matting waveform.

The connections are detailed in Fig. 64 along with the diagram of the wipe performed. Thus for a line wipe (i.e. vertical line moving across the screen) the line sawtooth out of point A is connected to variable bias from the main base potentiometer K (the linearily operated potentiometer such as specified for the fader amplifiers). The sawtooth plug bias is then connected to the main Schmidt trigger at point V, which generates matte waveform for the video switch. A field wipe is similarly obtained (Diagram 2) and a combination of these allows a diagonal wipe obtained by collecting line sawtooth (A), field sawtooth (E) and bias (K) to the trigger input (V). However, for a wipe from the adjacent corner, the line sawtooth is inverted in a phase splitter. Thus the connections are (A) to (S) and inverted output (T) to (E), (K) and (V) as above. As indicated in Fig. 64, other wipes are possible, for example a square edge (or corner insert) is possible. This is obtained by using two Schmidt triggers so that the line and field wipes are performed separately and then combined. This line sawtooth is clipped by trigger 1, field sawtooth by trigger 2. Bias from the main bias potentiometer is fed via two resistors of at least 1kΩ to act as a buffer between the line and field sawtooth. In this case the corner of the wipe moves diagonally, but if desired, separate bias from the X as Y bias potentiometers are used to bias the sawtooth before the triggers so that differential control of the line and field position (vertical or horizontal) is obtained.

In the above cases, the output of both the Schmidt triggers is fed to the main Schmidt trigger. Astable multi-vibrations are normally locked to line and field drives are used to generate square waves at line or field rates and at various multiples of this frequency. If at line frequency, for example the square wave output, when integrated, becomes a triangular wave so that the wipe produced is a 'Barn Door' wipe. This is as detailed in both Figs. 62 and 64. Combining the line and field versions of such a wipe becomes a 'diamond' wipe from the centre of the screen whilst using Schmidt triggers as with the corner insert gives a box wipe, i.e. a square moving in or out from the centre of the screen.

By integration of line and field frequency triangular waveforms a second time, a hyperbolic waveform is produced and when line and field hyperbolic waveforms are combined the result is a circle or an 'iris' wipe moving in or out from the centre of the picture. Combinations of this source of wipes are possible, e.g. a field barn door plus the line circle gives an elliptical wipe and many other such combinations are possible.

UNUSUAL EFFECTS

If the multi-vibrations are operated at several times the line and/or the field rate a rather unusual form of wipe is obtained. Examples of this sort of wipe can be seen on the BBC programme "Top of the Pops". A barn door wipe in this mode takes place six times per line if the multi-vibrator is run at six times line frequency. Also, with the field multi-vibrator at five times a box wipe will produce a square or rectangular patterned wipe; this particular pattern is very useful for checking linearity of monitors. Other patterns are obtainable as in Fig. 64. Unlocking the multi-vibrators from the line and/or field drives with adjustment of the multi-vibrator frequency to be nearly similar to a multiple of line or field rate gives a pattern wipe which rolls slowly up or down or from side to side.

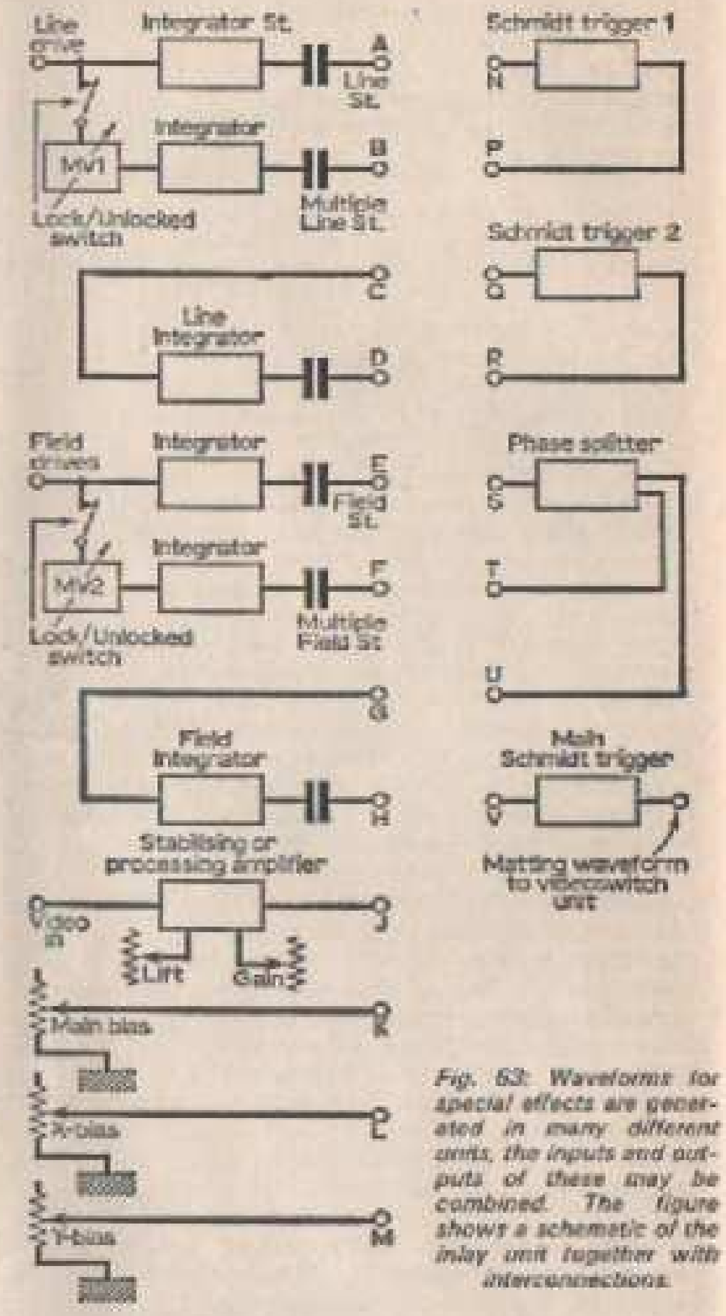


Fig. 63: Waveforms for special effects are generated in many different units, the inputs and outputs of these may be combined. The figure shows a schematic of the inlay unit together with interconnections.

SQUARES AND CIRCLES

Finally, a very special form of wipe can be obtained by using the line and field matting waveforms as for a corner wipe, to generate a diamond (square or circle with extra circuits) centered on the point that the corner of the wipe would occupy. This is done by using the X and Y potentiometers to control the position of the 'corner' as for the corner insert, then taking the outputs of the Schmidt triggers and integrating them to produce a triangular waveform centered on the triggering points of the Schmidt triggers. The line and field components are combined and biased by the main bias potentiometers before being fed to the main trigger. The size of the diamond is controlled by the main bias potentiometer, its position by the X and Y potentiometer. To generate the circle, two more integrator circuits are needed; a square requires two more Schmidt triggers.

FUTURE PROJECTS

A future project will be to switch between two selector plugs to allow immediate changeover from one wipe to another. Preliminary investigations would indicate that diode switching, as in the vision mixer, is satisfactory for switching of the waveforms, but where the various biases are applied relay switching is required. In practise, this would involve the connections to the bias potentiometers and the Schmidt triggers. Two sockets are to be mounted on the control panel and some of the interconnections within the plug are made with the switching diodes, control voltage for these being supplied from a wipe changeover switch via a spare pin on the plug. At first, ordinary relays mounted externally to the plug will be used, but subminiature relays mounted within the plug cover will be used when the price and availability becomes more favourable. These relays are almost as small as a transistor, use wire connections and operate at very high speeds, all of which make them ideal for use in this application.

SETTING UP

When setting up these circuit wipes a certain amount of juggling with the bias from the potentiometers will be required so that the wipe occurs in the middle of the range of the bias potentiometer; this is particularly true for the more complex wipes. A bias resistor mounted within the plug from earth or −12 volts to the bias supply will correct for this, the value of the resistor being selected to give the correct amount of extra bias.

. . . to be continued

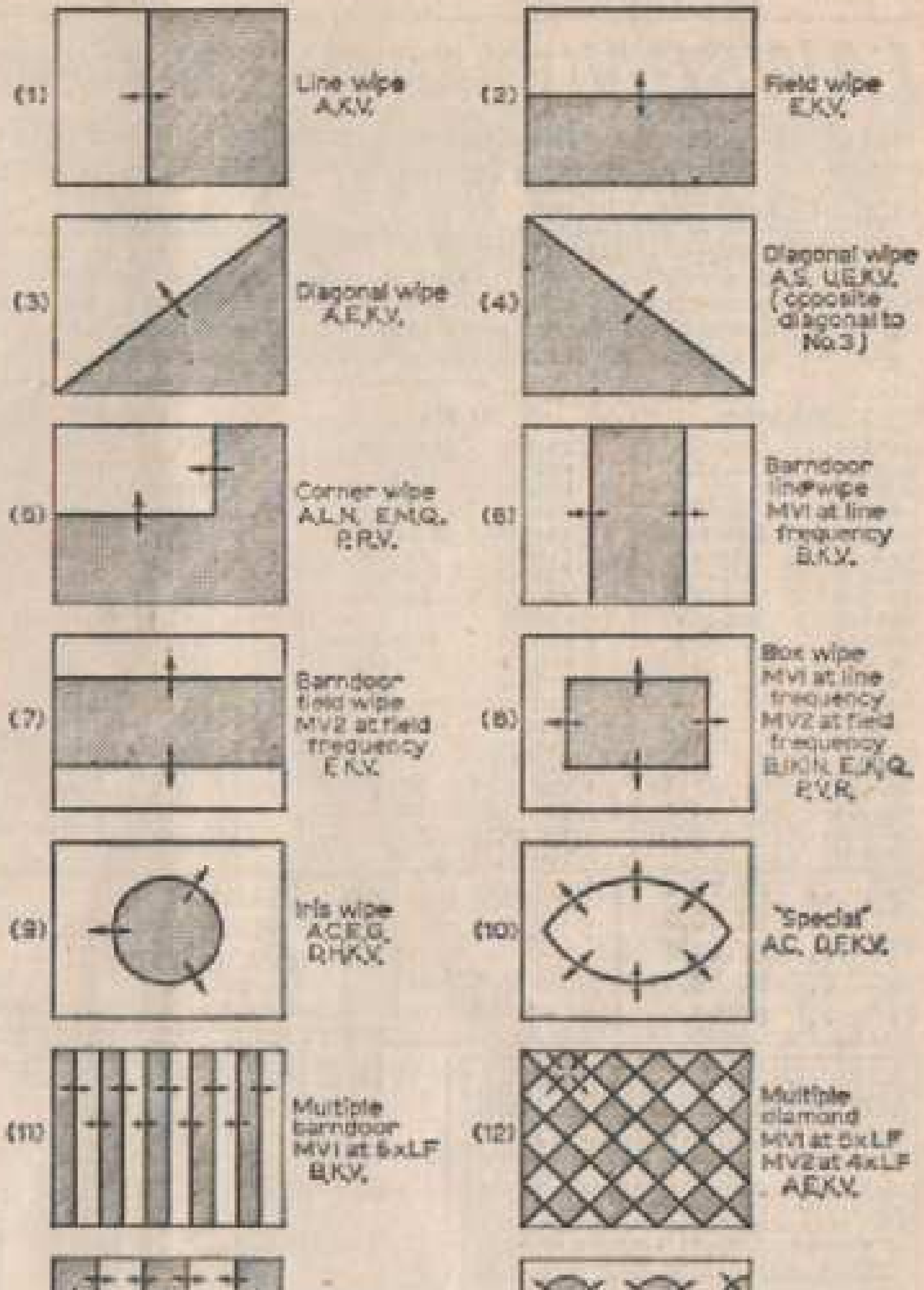


Fig. 64: The various types of electronic wipes.

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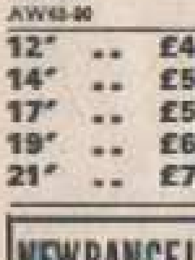

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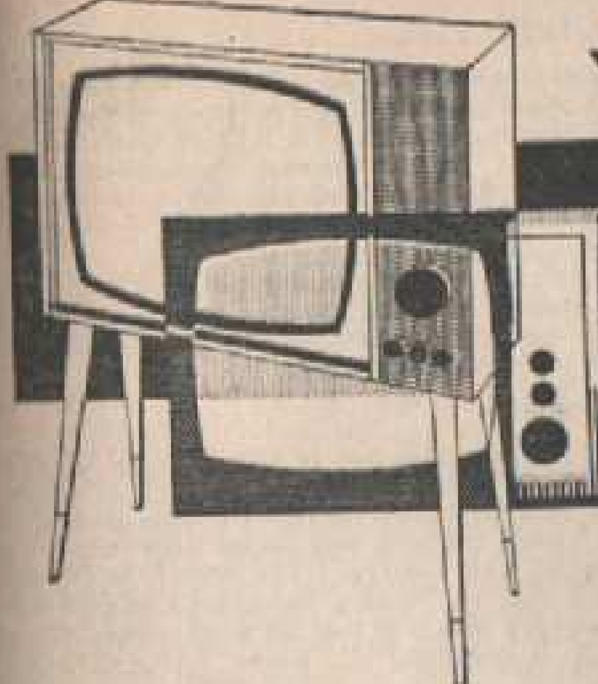

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MURPHY V270C

Please can you advise me of the correct method of removing the CRM142 c.r.t. from its housing?—D. Jones (Neath, Glamorgan).

Unbox the receiver, remove focus assembly, c.r.t. base connector and ion trap magnet. Discharge and remove e.h.t. connector, unclamp the c.r.t. bowl (two large bolts around front of tube) and withdraw c.r.t. forward.

EKCO T311

Would it be possible to replace the U25 e.h.t. rectifier with type U26? In addition, would a special type of B9A valve holder be required?—D. Main (Swansea, Glamorgan).

It will be perfectly satisfactory to replace the U25 by means of fitting a B9A valve holder, and utilising a U26. There are special shrouded valve holders manufactured to reduce the possibility of flashover from the pins, and one of these should be fitted.

GEC BT1252

There appears to be trouble in the line scan circuitry, because after a short while the picture width drops off considerably. Replacing the PL81 effects only a temporary cure. The width control is at maximum even with a new line output valve. Replacing the U329 makes no difference. There is also some compression on the left-hand side of the picture. What conditions would be likely to cause premature failure of PL81's?—W. Corkish (Douglas, Isle of Man).

Reduced horizontal scan should first lead to a check of the h.t. line. Check that the mains tapping is correct for the domestic mains supply and if the trouble persists, have the h.t. rectifier checked and replaced if necessary. Persistent line amplifier valve failure could be caused by a change in value of the screen grid resistor (going low) or a change in the mark/space ratio of the line drive waveform, resulting from changes in components between the oscillator and amplifier control grid.

PYE C17F

Owing to a reduced picture size, the h.t. metal rectifier and smoothing capacitors were replaced. The set worked very well for about a week or so, but now the contrast control has ceased to function and the picture has a "watery" and negative effect.—R. Cox (Orpington, Kent).

The trouble could be almost anywhere in the automatic picture control (a.p.c.) circuits, and if so, will probably involve the use of an oscilloscope and reliable test meter to trace. If a BY100 type silicon rectifier has been fitted, check that the h.t. line is not too high. An h.t. in excess of 200V on this model can give rise to peculiar symptoms, particularly in the line timebase where width decreases after a prolonged run.

PAM 600S

The sound is very badly distorted when the volume control is set at normal listening level. In an attempt to remedy this, I have twice replaced the PCL82 sound output valve. This clears the distortion for about a month, and then it gradually gets worse again.—A. Campbell (Glasgow, S.4).

The two most frequent causes of persistent sound distortion on this receiver, are leakage of capacitor C53 (47pF) and C56 (0·005μF). We would advise you to check these by substitution.

EKCO T344

This receiver has critical field lock and picture judder. Valves 6/30L2, 30FL1 and 30PL13 have been replaced—but without improvement. Increasing contrast locks the picture, but only at its maximum setting, which results in an over-contrasted picture.—S. Creed (Birmingham 34).

The most likely cause of your trouble is a faulty interlace diode, which is mounted on the rear of the printed circuit panel containing the 30FL1 and 30PL13 valves. Another frequent cause of trouble is a defective blocking oscillator transformer.

EKCO T164

I have recently acquired a second-hand version of this receiver. I should be obliged to know if it can be adapted at least for local reception of Televis Eireann (about 20 miles) and possibly BBC and UTV from Northern Ireland.—M. Huggard (Greystones, Co. Wicklow).

This model was designed for reception on any one of channels 1—5 only. About ten years ago it could be adapted quite cheaply to receive ITV programmes, but in view of the present age of the chassis, we would hesitate to recommend a conversion.

CRT REPLACEMENT

Will you please tell me if the AW43-88 is interchangeable with a CME1706?—E. Whitehouse (Birmingham 24).

The AW43-88 has a 6·3V heater, the CME1705 a 12·6V. The latter also has a slightly shorter neck. Apart from this they are very similar and the AW43-88 could be fitted ignoring the difference of heater voltage rating.

BUSH RU135

The scanning lines are pairing on 405 but satisfactory on 625. There is a preset interlace control which I have checked and found to be perfect. It however has no effect on the line pairing. A local "serviceman" has told me that the interlace control does not control the line spacing, it just balances the diodes.—J. Ford (Worthing, Sussex).

Check the interlace diode itself (8NR3) and associated components. Also check the video amplifier-sync separator stage for correct values, remembering that several cathode (video) components are only in circuit when switched to 405-line operation.

PHILIPS 1768U

I am unable to lock the horizontal hold control and in an attempt to remedy this I have replaced the line oscillator valve (PCF80), also the 330kΩ resistor in series with the line hold control. I have also tried a new line output transformer. By paralleling the 330kΩ resistor with a 270kΩ the line hold locks with the control in the centre of its travel.—V. Jarvis (Merthyr Tydfil, Glamorgan).

We suggest that you note the effect of disconnecting the vision interference limiter control. This sometimes causes line hold trouble.

BUSH TV24C

This receiver has a very weak picture and sound. I have changed the tuner valves but this does not bring about any improvement. I have tried the same aerial system on my other receiver (McMichael M72T) and received excellent picture and sound.—J. Evans (Merionethshire, Wales).

There are quite a number of things that could be wrong with your receiver, but as a start, we suggest you check the aerial input socket, one of the band III sockets should connect to the band I centre tag. Check the EF80 valves behind the tuner and voltage supplies. Also check tuner resistors and contacts on the switches.

BUSH TV53

This set suffers from constant field slip or roll. I have changed the valves around the main deck. These include PCL83, ECC82 and ECC83, but without improvement. Are there any components I could replace by substitution around the sync separator circuit?—G. Read (Skerries, Dublin).

The suspect components are the interlace diode (which goes to pin 7 of the ECC83) and associate resistors, particularly the 3·3MΩ. Also check the 0·001µF and 0·02µF capacitors.

K-B LFT50

The fault on this set is the display of two half-sections of the picture in perfect lock. The picture can be made to roll by operating the vertical hold control but locks near the mid position of the control. The 6SN7 has been replaced and the many associated capacitors and resistors checked but all were found to be in good order.—D. E. Jones (Aberystwyth, Wales).

There are one or two possible causes of the trouble you have described. The first is that the 0·05µF coupling capacitor to the control grid circuit is leaky. The second is that the 0·05µF capacitor from the junction of the 330kΩ and 150kΩ resistors is leaking—to chassis. Also check the 220pF capacitor.

BUSH TV135U

The raster on this receiver has pin-cushion distortion. I have adjusted the correction magnets but they do not rectify the fault. Is it possible to bend the line coils in any way to correct this?

When facing the front of the receiver the left-hand magnet is north at the top and the right-hand magnet is south at the top.—H. Palmer (Hounslow, Middlesex).

It is difficult to bend the deflection coils unless it can be seen where they are at present distorted, in which case a degree of straightening may be attempted. The correction magnets are at present properly presented. We suggest as a last resort, remove them.

K-B WV20

There are alternate light and dark stripes down the left-hand side of the picture: is this "ringing"? This is more pronounced on raster than picture. The 625 Test Card does not show left-hand raster edge although width is variable by controls. I have changed PL302, ECC81 and C125 booster reservoir capacitor.

On removing the lead from the BBC-2 preamp to the u.h.f. aerial socket on the set, the centre spigot of the set socket snapped off. This socket (Egan) is isolated but does not appear to contain capacitors or resistors. I have fitted a standard isolated socket (2 x 47pF + 2 x 2·2MΩ) but this causes loss of signal.—C. Everett (Sellindge, Kent).

There is little that can be done about the fault striations only visible on an unmodulated raster. You could try a slight adjustment to the linearity sleeve.

The u.h.f. aerial socket should be isolated with 270pF capacitors.

FERGUSON 3623

The sound is good but the screen is blank. I have replaced the EY88, PL500 and PY801. As far as I can tell, the EY86 does not light up.—H. Mott (Swindon, Wiltshire).

If the PL500 tends to overheat, check the PCF808 line oscillator, also C104 (0·01μF). If the PL500 does not overheat, check the 0·22μF boost capacitor C101. If the PL500 has a heavy negative drive to the grid at the junction of R129–R130, check R130, R131 and Z3.

BUSH TV66

I have replaced the c.r.t. in this set, but I am unable to obtain a raster.

EHT and line whistle are present but when the brightness control is fully turned up, only very faint raster is discernible. Alteration of the ion trap magnet does not improve this.

When the brightness control is turned half-way up, flashing occurs in the PY81 efficiency diode. I have replaced this valve but the condition remains the same.—E. Poulton (Birmingham).

We would urge you to find the correct position for the ion trap magnet. Check the tube base voltages, over 300V at pin 10 and about 120V at pin 11, up to this figure at pin 2 with the brilliance fully up. PY81 replacement may also now be necessary.

BUSH 125

The sound is perfect but there is no raster or line whistle. With an ohmmeter between chassis and all points on the l.o.t. and caps of PY88, PL38, there is a dead short. I removed the clip from the l.o.t. and chassis and this cleared the short but still no raster.—T. Russell (Worcester).

We would advise you to replace whichever of the two 0·1μF capacitors (3C23 or 3C24) is shorted.

DEFIANT 7101

Due to reduced scan, I have changed the 30P4 valve and this seems to have made only a slight difference. Also, I have tried to obtain an HT60 rectifier and been unsuccessful: can you name a source of supply?—J. Lyne (Oldham, Lancashire).

It is common practice to replace the HT60 with a BY100 (or equivalent) silicon power diode in series with a 25Ω 10W resistor, wired if desired across the existing rectifier, leaving this in position.

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PRACTICAL TELEVISION, MAY, 1967

TEST CASE -54

Each month we provide an interesting case of television servicing to exercise your ingenuity. These are not trick questions but are based on actual practical faults

The fault in an Ekco T368 was displayed by waviness of the vertical parts of the picture—rather like the symptom of hunting in a flywheel-controlled line sync circuit. The effect in this case, however, could not be altered in any way by adjustments to the line hold control. It was also noticed that the horizontal scan was down in amplitude giving verical dark edges to the sides of the picture.

Low h.t. voltage or hum in the line circuits was suspected, but emission and heater/cathode insulation tests of appropriate valves and value and leakage tests of the main electrolytic capacitors failed to throw any light on the problem.

Most of the smaller components in the line generator, line output and booster diode sections all appeared to be in good order and it was finally assumed that the trouble must lie in the line output transformer. But the sympton, unfortunately, was still present after replacement of this transformer.

There is one component that remained untested and which is often the cause of this kind of sympton. Which one is this? See next month's Practical Television *for the solution and for another item in the Test Case series.*

SOLUTION TO TEST CASE 53

Page 332 (last month)

A major clue to last month's Test Case was the symptom of slightly reduced width. A voltage test would have shown this to be a little low from the output of the rectifier, but replacing the h.t. rectifier would *not* have solved the problem. The voltage would have still been a little low and the field lock very poor—which is the main symptom.

The mains hum was not abnormally high on sound, but as a last resort the main electrolytic capacitors were shunted by a test component, and immediately all the symptoms disappeared and the field locked solidly. There was only a very slight change in tone of the residual hum from the loudspeaker. The main trouble was being caused by the large 50c/s ripple from the h.t. rectifier distorting the field sync pulses, and the reason why this could not be heard from the loudspeaker was due to lack of very low frequency response of the audio circuits and speaker. The slightly reduced width and definition was caused by the low h.t. voltage.

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